The Dock & Harbour Authority

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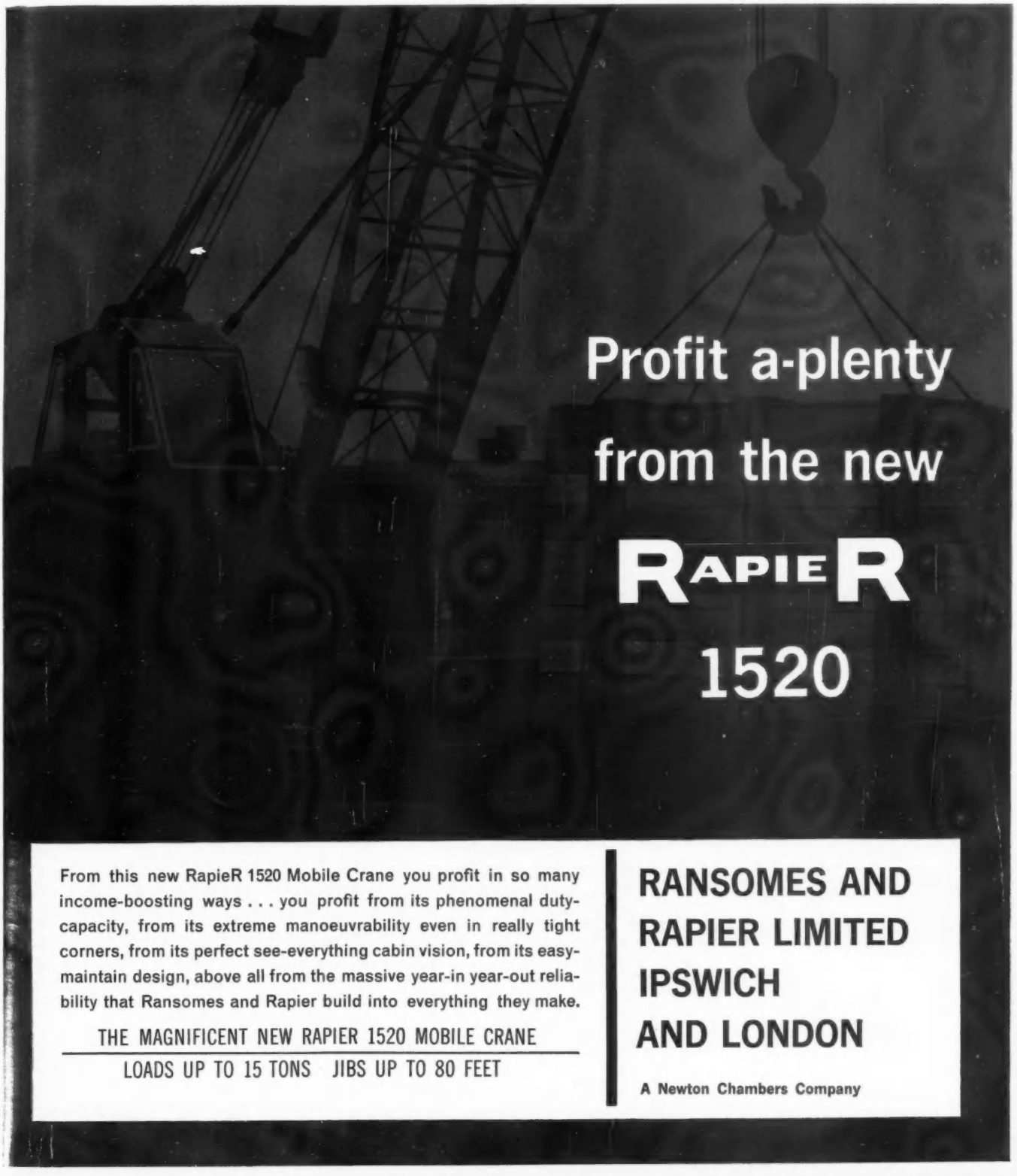

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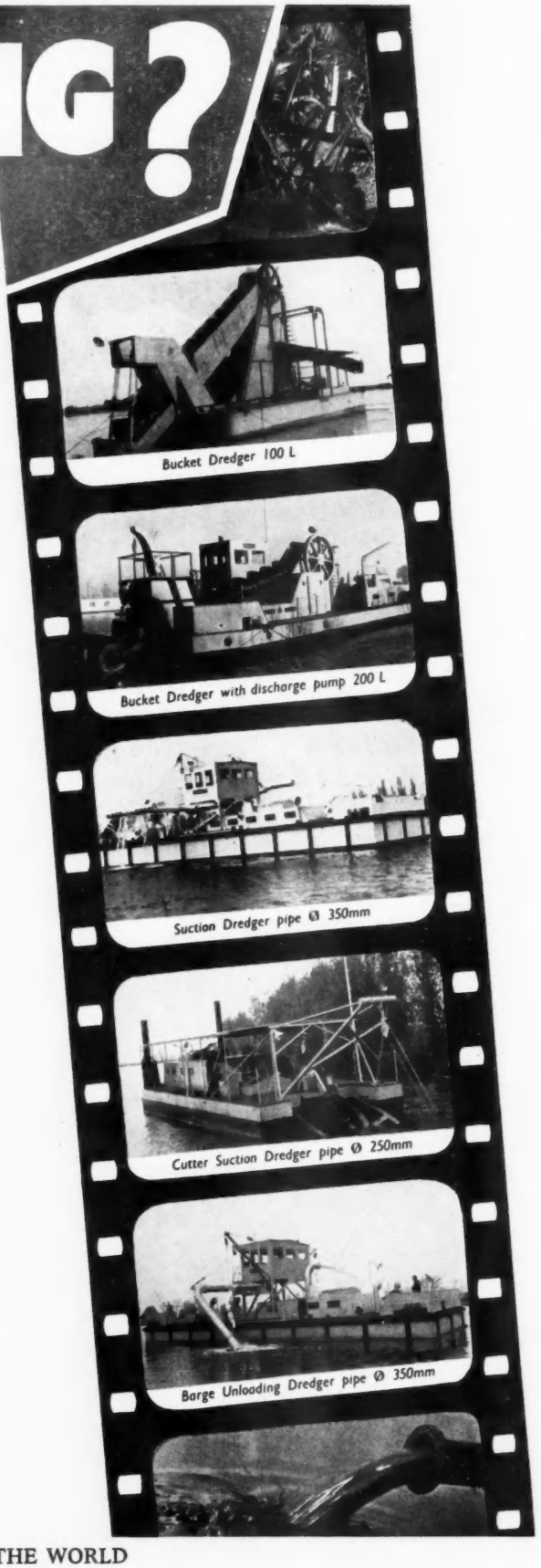

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AGENTS THROUGHOUT THE WORLD

The Dock & Harbour Authority

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Editorial Notes

The Port of Haifa

Our principal descriptive article this month concerns the early history and the remarkable recent development of the Port of Haifa. After the gradual decay of the Ottoman rule, the growth and vitality of modern Palestine under the mandatory power and until the partition of the country in 1948 was outstanding. The large influx of new capital for investment and, above all, of Jewish skills and talent from all over Europe and America during the 1930's, completely transformed the country. Although primarily agricultural and depending largely on citrus exports, a good beginning was made at diversifying the economy by the establishment of secondary industries. To give effect to vigorous civic development, whilst preserving the natural beauty of a small country so rich in religious and historical association, far-sighted planning legislation was called for, and, although the partition and subsequent political upheavals have compelled the new State of Israel to develop still more intensively and to adopt a large measure of economic self-sufficiency in a way which could not have been foreseen, the work of the previous administration in the planning sphere undoubtedly laid a sound foundation for the future.

In the changed circumstances after the war, however, the modest facilities of the Port of Haifa which were first opened to traffic in 1933 soon proved inadequate. The original planning made some provision for future enlargement but not on a scale required by possible future contingencies, nor has the alignment of existing work been particularly suitable for a phased development of additional facilities. Much work has now been done in extending the initial three deep-water berths westwards, and a further prolongation is now in progress involving a big dredging programme of the shallow anchorage within the shelter of the breakwater. At the same time, supplementary berths have been constructed at the outlet of the Kishon River in the hitherto unprotected Bay of Acre, and further development is being planned in this area including the provision of a shipyard in which Dutch interests are participating. The defects of the original layout are now becoming more obvious. In particular, the oil dock opened just before the war to supplant the submarine loading terminal of the southern branch of the I.P.C. pipeline from Mafraq and Kirkuk (no longer now in use) is clearly shewn to be inadequate and wrongly sited and will need to be removed to a new position outside the crowded commercial port. The port is now being worked more intensively, perhaps, than any other port in the world, as will be substantiated by the figures given of cargo movement expressed as an average tonnage over each foot of quay—an object lesson of what can be achieved by a closely knit organisation in making the fullest use of its available resources.

The article is particularly interesting in its references to the different forms of administration which the port has undergone since its inception. Under the Mandate, control was exercised first by the Customs and Excise Department and later by the Palestine Railways, forms of administration which in other places have proved ill-adapted, constitutionally and psychologically, for the conduct of international port srvices. The port now enjoys a fair degree of self-determination but it is still operated substantially as a government department rather than as an agency of government. In the near future, however, it is intended to establish a new autonomous statutory corporation, to be known as the Israel Ports Authority, which will have jurisdiction not only over the present Port of Haifa but over the newly projected port at Ashdod some 20 miles south of Tel Aviv.

A Perforated Vertical Wall Breakwater

In recent months we have printed a number of articles concerned in one way or another with the phenomena of wave action under different boundary conditions. The movement of moored ships, their behaviour when berthed alongside a quay, berthing impact, the dynamics of ship propulsion, all are examples common to our experience. The suppression of waves by compressed air, the saltation or mass transport of bed material by wave action alone are other instances of practical importance, which depend for their explanation on a thorough understanding of the principles of wave motion and propagation as expounded almost a century ago by the classical hydrodynamicists, notably by Stokes and Lord Rayleigh. The technique of mathematical analysis is daunting and consequently the subject has always proved something of a stumbling block. For an admirably clear explanation of wave action in shoaling water, however, in non-mathematical terms, we would like to commend the short paper just produced by the Hydraulic Research Laboratory entitled "Coast Erosion and Defence" (Hydraulics Research Paper No. 3) which we referred to briefly in the Journal last month.

The article we print in this issue concerns the action of waves upon the vertical face of a mole or retaining wall sited in shallow water. A possible means of dissipating harmlessly the energy of the wave train by mounting a perforated screen or grillage in front of the main structure has been investigated by model experiment. It is, of course, far preferable to allow waves in shallow water to break upon a sloping rubble mound faced with a stone riprap in the interstices of which energy is absorbed in friction, a con-

dition often simulated in model tank experiments to avoid wave reflection from the end of the tank together with the provision of a labyrinth of fine gauze for reducing wave amplitude. In general, it is not good practice to interpose a vertical face in conditions where waves tend to break, that is, when the velocity of wave propagation is independent of the wave length and becomes proportional to the square root of the depth. In deep water, of course, the velocity of propagation is proportional to the square root of the wave length and, apart from orbital movement, there is no bodily translation of the water particles. In the circumstances related, however, no material for forming a rubble mound is available and consideration had to be given to an alternative form of barrier. Hydrodynamically the solution is extremely interesting, although its practical application at full scale may introduce almost insuperable difficulties. To mention only one, any perforated screen employed in this way must be made of remarkably durable materials to withstand the constant jetting and scouring action of water heavily charged with sand. The introduction to the paper makes reference to the action of acoustic waves impinging normally on a porous or perforated plate, a phenomenon which has led to the introduction of the well-known acoustic tile, but the authors are careful not to press the analogy too far for compressional waves in gases behave quite differently from the gravitational waves in incompressible fluids which is the particular object of the exercise.

The Problem of Erosion and Siltation in Channels

Any new development in "the art of directing the Great Sources of Power in Nature for the use and convenience of man" is always likely to be of interest to many of our readers. We publish in this issue an account of a new way of taking advantage of one of the less familiar phenomena of hydraulics and turning it from a loss to a profit. We refer to the James Thompson effect in which a current flowing with uniform velocity in a straight length of river or canal is changed into longitudinal spiral flow in rounding a bend. The direction of the spiral is such that the water flows outwards towards the concave bank on the surface and returns inwards along the bed, thus causing scour of the concave bank and accretion of the inner bank. This inconvenient result is known to and deplored by river engineers to whom it means more bank protection and dredging.

In Pakistan, India and Russia this phenomenon has recently been turned inside out to display its silver lining. Where unwanted scour or sedimentation occur in a channel, means have been devised for setting up a gentle spiral component in the flow in that direction of rotation calculated to induce scour where the bank is being scoured. The article by Mr. Batalin in this issue describes floating and fixed vanes near one side of the river, so inclined as to set up a transverse surface current. In these three countries this method has been found helpful in maintaining the state of the channel.

Although the deflectors mentioned by Mr. Batalin have not so far been applied in this country, a considerable volume of research on helical flows was carried out at the Imperial College of Science and Technology. Some conclusions resulting from part of this research were published in this Journal in July, 1955, in a paper entitled: "Helical Flows in Open Channel Bends" by T. M. Prus-Chacinski, Ph.D., M.I.C.E.

The Future of British Ports

The announcement by the Minister of Transport in Parliament on March 29 that a special committee is to be set up to consider to what extent the major docks and harbours of Great Britain are adequate to meet present and future national needs, and whether the methods of working can be improved, will occasion no surprise. For some time past there has been widespread concern in the industry at the delays in the movement of cargoes through British ports and a presentiment that new techniques and ideas in this field are not being pursued energetically enough. The terms of the announcement will be sufficient to dispel any thoughts that this will be "just another committee." Since the war there have indeed been at least four governmental committees or working parties charged with reviewing specific aspects of the situation and little of consequence has emerged from their inquiries. It has been emphasised that the new committee's terms of reference will enable it to look at every facet of the problem from management to labour, equipment and finance. Furthermore the Minister intends to have a "dispassionate" committee without a representative of the employers or of organised labour, but it would be able to take evidence. This, of course, is the crucial point.

Judging by the direction which published criticism has taken, the calling of an inquiry of this nature must be regarded as something of an indictment of the port authorities concerned. Since they are mostly constituted as public trust corporations with all the expertise at their command and therefore, one might suppose, containing all the ingredients for providing a solution, it might be thought that they had it in their own power to put matters straight. On the contrary, with such administrations the pattern of working and the form of the institutions based upon it often become set in a rigid mould, either by custom or by statute, and radical new thinking is precluded.

If the constant stream of recrimination and rebuttal voiced by the constituent sectional interests is anything to go by, little in the way of constructive suggestion can be expected from that quarter. Obviously, therefore, it becomes necessary to take a fresh look at this pattern, which long usage apparently has sanctified, to decide whether a rearrangement of duties among those best suited to perform them could eliminate present areas of conflict and misunderstanding and lead to a better employment of facilities available. An outside impartial official body would be able to take a clearer view of the situation and alone would be capable of undertaking the objective study entailed and so setting in train a proper course of development for the present and future needs of an expanding commerce.

Readers of this Journal will recall that on many past occasions we have compared the organisation and performance of British ports with those of some of the principal Continental terminals, in particular with Rotterdam which today enjoys so enviable a reputation for efficiency. At Rotterdam it has been the prevailing practice to alienate deep-water frontages after reclamation to private developers whose capital outlay is secured by long-term leases varying between 25 and 75 years, the port authority as such concerning itself in the main with directing the style and course of development into channels which serve the overriding national interest. A similar policy is being adopted in the Port of Antwerp. It is perhaps too late or unacceptable to public opinion to revert to this practice in the United Kingdom, so that other ways and means must be found for establishing a basis on which private enterprise can work effectively whilst assuring the primacy of public regulation. We published an article on this subject in 1959 and, as a forensic study of the whole industry is now contemplated, a closer examination of the argument might not be inappropriate. Provided the right incentives are brought into the system at every stage so that restrictive pressures are relieved, there is no reason why the industry should not automatically go forward to meet its new tasks, confidently and less introspectively, and be self-sustaining in all its operations. But the sequence of operations must be regulated so that each can be completed in a way which facilitates and serves as a stimulus to the next, a necessity which is so obvious to production management but not apparently to our port administrators.

The Port of Haifa

Details of Construction and Administration

By J. MONETA, M.A., F.C.C.S.
(Head of Research Section, Port of Haifa)

HAIFA PORT, Israel's main gateway to the outside world, is situated on the southern shore of the Bay of Haifa. This beautiful bay, protected by Mount Carmel on the south-west, is the only strong indentation on the Israel coastline to provide a natural anchorage. From the earliest times shipping found shelter here from the Mediterranean gales, but it was only in the late 1920's that the present Port of Haifa was conceived and in 1933 that it was officially opened to traffic.

Israel's second largest city, Greater Haifa has a population of 231,000. It stretches from the sea up to the western slopes of Mount Carmel and down again on its eastern side far into Haifa Bay.

Haifa down-town, on sea level and in the lee of Mount Carmel, contains the port, two railway stations, and the central overland bus terminal, and is the principal shipping, foreign trade, banking and wholesale business centre. To the east and north-east the town spreads into Haifa Bay which comprises the town's industrial zone, workers' suburbs, and the Kishon Auxiliary Harbour. Halfway up Mount Carmel is the main residential and retail shopping centre while the crest of Mount Carmel and its upper slopes are studded with residential quarters, hotels, boarding houses, and beautiful parks. Here, also, is the terminal of the new underground funicular railway connecting the Carmel with down-town Haifa.

Shipping, industry, foreign and domestic trade maintain the economic life of Haifa. The town's industries include an oil refinery, connected by a 16-in. pipeline to the oilfields of Southern Israel and to Eilat Harbour on the Red Sea, Portland cement works, chemical and fertilizer plants, foundries and steel mills, ship repair yards, glass works, textile mills, motor car plants, and canning and ice factories.

The main port of Haifa has roughly the shape of a rectangle, the sides of which are formed to the south and west by deep and shallow water marginal wharves, to the north by the main breakwater, 7,250-ft. long, and to the east by the lee breakwater, 2,510-ft. in length. The width of the entrance channel to the main port is 600-ft., and its minimum depth at m.s.l. is 37-ft.

The harbour basin covers an area of 10,968,383 sq. ft. (252 acres) and is undivided except for its eastern part where two jetties jut out from the southern shore line of the harbour towards the north, almost parallel with the lee breakwater. The jetties divide that part of the basin into an oil dock and a general cargo dock, separated from each other by a safety zone. The harbour basin is flanked to the west and to the south by a narrow strip of land that occupies an area of 3,743,300 sq. ft. (85 acres) and terminates on the water front in marginal wharves.

These wharves run in a north-west to south-east direction and measure 4,600-ft., of which 2,884-ft. are deep water quays for ocean-going vessels and 1,716-ft. low-water quays for small vessels and lighters. Water depths alongside the deep water wharves vary from between 30-ft. to 36-ft. The depths are easily maintained by occasional dredging since silting within the harbour is negligible. Littoral drift is felt mainly at the harbour entrance but here, too, it is not excessive.

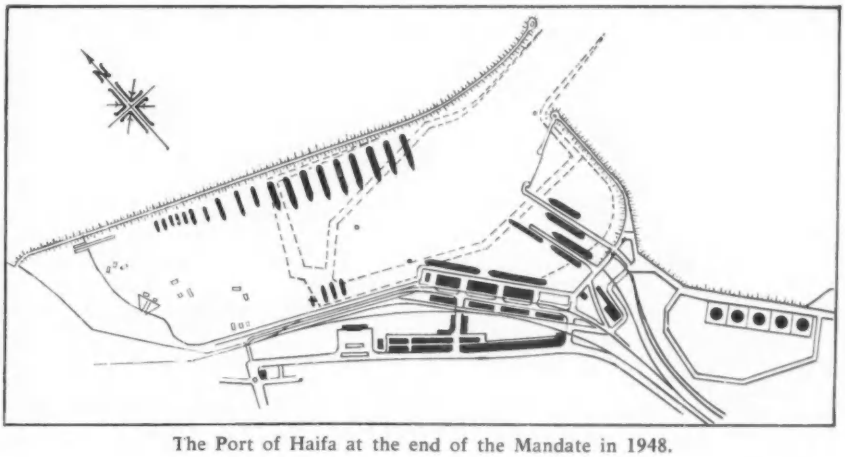
To the east of the main port, around the lower reaches of the Kishon rivulet, lies the Kishon Harbour, a newly created inland auxiliary harbour with a considerable reserve land area of 1,112 acres. The Kishon Harbour consists at present of an outer harbour basin, protected by two small breakwaters, one main channel dredged to a depth of 25-ft. over a length of 2,296-ft., and to a depth of 21-ft. over a stretch of 1,132-ft., and one branch channel 699-ft. long, 13-ft. deep, which serves as fishing dock. On the main channel there is one cargo wharf, with three berths for small to medium-sized vessels.

Firm, calm weather prevails for the greater part of the year. Only in winter, occasional south-westerly gales may make it dangerous for ships in light condition to enter the harbour or remain at anchor in the roadstead, and it is common practice for such ships to proceed to sea.

Before the construction of the modern Port of Haifa, seagoing vessels had to anchor off-shore and lighters were employed for the transport of cargo and passengers to and from a small jetty. While natural protection was afforded to the leeward side of Mount Carmel, the roadstead lay open to gales from the north and west. In bad weather, loading and unloading were frequently interrupted and the damage and loss of cargo were considerable.

The first mention of Haifa Harbour dates back to the second century A.D. but the main ancient international traffic by-passed the Carmel and Haifa and reached the sea either to the north at Acre or to the south at Caesarea. For 2,000 years Acre remained the main port of the region but gradually began losing its dominating position due to progressive silting up and the trend toward increasing size and draft of vessels. In the 18th century more and more vessels turned from Acre to Haifa Harbour, where the bay had greater depth of water and was also protected by Mount Carmel against the worst south-westerly gales.

The decisive turning point in the economic development of



The Port of Haifa at the end of the Mandate in 1948.

Haifa came in 1831 when Ibrahim Pasha, the son of Mohammed Ali of Egypt, used Haifa Harbour as a base to land his troops and conquer Acre and the rest of the country. The devastation of Acre caused many of its inhabitants and all of the foreign consuls who lived there to move over to Haifa. With them came a good part of Acre's trade.

The shifting of trade from Acre to Haifa gathered momentum when the Hejaz railway branch line from Damascus to Haifa was opened in 1905, followed in 1908 by the building of a new jetty in Haifa Port for loading the cargo arriving by the new railroad. Until then Haifa had been a grain handling centre only for the crops of the Sichem and the Yezreel valleys, but now it became the export outlet for the Hauran and Basan fields, the corn chambers of Syria, since the cheap and quick carriage by rail to Haifa completely ousted the camel caravans that in former days had brought the grain to Acre.

The immediate economic hinterland of Haifa also grew in importance with the foundation of Zionist agricultural colonies near Haifa and with the steady influx of Jewish immigrants into the town.

The development of Haifa is reflected in its population figures: about 3,000 between 1830 and 1870, over 8,000 in 1891, 15,000 by 1913, 24,000 in 1923 and 50,000 in 1931. Four years later the figure had doubled and stood at 100,000 inhabitants. The last rapid rise was of course directly connected with the building of the modern port.

Construction of the Modern Port

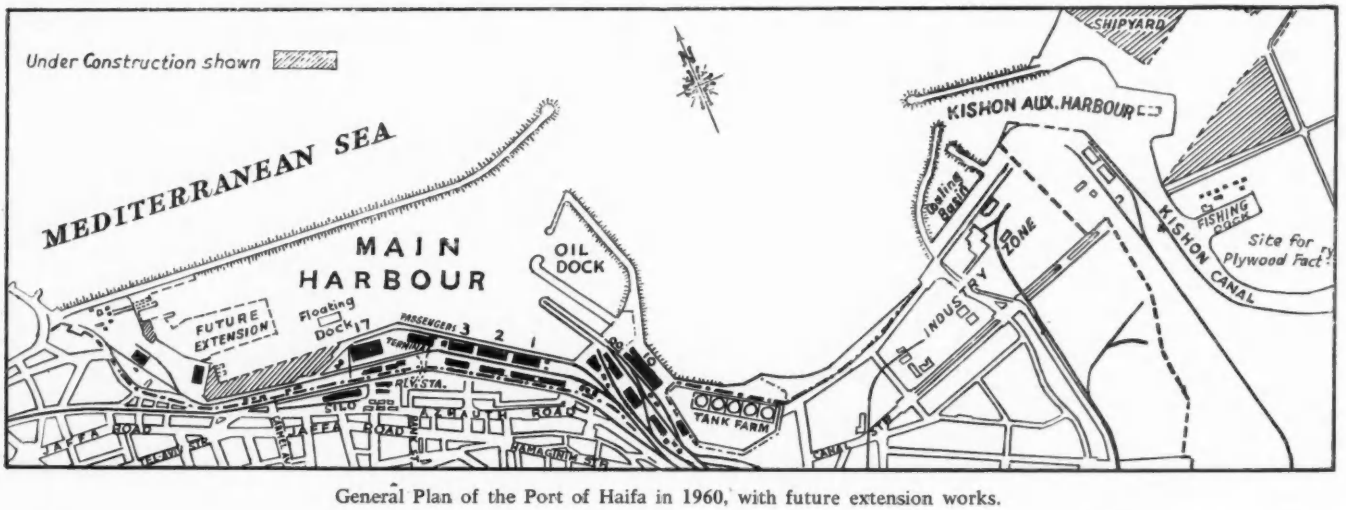
Prior to World War I the Turks had already toyed with the idea of building a port at Haifa. They started some small-scale reclamation on the eastern end of the present harbour, but the outbreak of the war put an end to that work. After 1918 Palestine was occupied by the British under the Mandate and it was they who took up the idea again of constructing a modern port at Haifa.

Trial borings began as early as 1920. Two years later Sir Frederick Palmer, a consulting engineer, surveyed the entire coast of the country at the invitation of the Palestinian Government and confirmed that Haifa was the most suitable site for the construction of a deep-water harbour. His report was adopted and one year later the preliminary survey and plans were prepared. Actual construction of the main breakwater began in 1929, and in the autumn of 1931 vessels could already moor within the shelter of the main breakwater then still under construction. In the autumn of 1932, vessels were moored to both the main and the lee breakwaters, and in December of that year cargo handling began over the lighter wharf. On October 31, 1933, the harbour was officially declared open. It was then but modestly equipped.

There were three berths on the main wharf, enough to accommodate three large or four small cargo vessels, and two transit sheds. It owned one 15-ton fixed derrick placed on the east end of the new wharf, two five-ton travelling gantry cranes on the lighter wharves and one 15-ton floating crane. There were as yet no coal or oil bunkering facilities for vessels. But the harbour soon developed. The Iraq Petroleum Company's pipeline was brought into the harbour and the first oil was exported from it in 1934. An oil dock was built in 1937. By 1938 a cargo jetty had been constructed, and storage areas, covered and open, had reached a total of 547,074 sq. ft.

The Second World War somewhat slowed down development but the end of the Mandate in 1948 and the creation of the new State of Israel gave fresh impetus to the port's growth. Later the sealing of the land frontiers by the Arab neighbouring countries made Haifa's development even more vital to Israel.

The port in 1948 was obviously inadequate to meet the needs of the new State. All port facilities were insufficient. There was but one wharf, 1,434-ft. long, and one cargo jetty of 951-ft. able to accommodate ocean-going vessels, and even there depth alongside was limited so that large passenger liners or cargo vessels drafting over 30-ft. had to be moored to the breakwater. Shallow water berthage covered only 814-ft. There was no repair dock for ships. Storage facilities were scant: 336,000 sq. ft. of transit sheds, 437,000 sq. ft. of open dumps. Even these facilities could not be fully utilized for lack of mechanical stacking equipment. The port had no grain elevator, no modern general cargo handling equipment, no special bulk loading facilities, except for oils whose source of supply in Iraq had been cut off. Congestion was imminent, especially since a low storage tariff invited the use of the transit sheds, for long-term storage. Passenger facilities were non-existent. Utilities were in a poor state: the power and light networks were inadequate, preventing satisfactory lighting of wharves and the efficient use of night shifts; water, fire and sewer lines were scarce; port roads were too narrow and insufficient in number; the port fence and gates needed a thorough overhaul; maintenance facilities were unsatisfactory. The Port Authority and the port contractors were short of experienced staff. There were very few skilled longshoremen left as the Arab labour, on whom the port had relied almost exclusively during the Mandate, had left the country. Jewish labour had to



General Plan of the Port of Haifa in 1960, with future extension works.

General view of Western Cargo Wharf extension works now in progress.

be recruited from nearby factories and trained as dock hands around the nucleus of Jewish workers who had been in the port before. Unaccustomed to the new work, these labourers tended to leave their jobs at the first opportunity, and the rapid labour turnover impeded proper training. Gangs were not permanent but were grouped afresh each day, with gang leaders alternating at random, which left no room for the evolution of any team spirit. Cargo incurred heavy damage through improper and negligent handling, and theft and pilferage were rife. Output was low, approximately five tons per stevedore per shift.

Port organisation, too, had inherent weaknesses. The police force was independent of the Port Authority and had been trained for general police duties rather than specific port requirements. There was no tally by the Port Authority at ship's side; this left a dangerous gap in the span of control between ship's rail and cargo sheds where the goods were tallied into the custody of the port. The cargo services—stevedorage, lighterage, and porterage—were divided among three separate contractors which interfered with efficient co-ordination of work and deployment of manpower. To make things worse, the lighterage service was shared out between one of the contractors and the Port Authority. Because of insufficient deep water wharves the port had to rely heavily on lighterage, some 50% of all import cargoes being lightered; this meant double handling for a good part of the port's trade. Statistics were rudimentary and provided no means for effective control of operations. Tariffs were involved and lacked coherence.

These multifarious problems could only be solved under a carefully planned development scheme. Thus originated in 1949 the Knappen-Tippetts-McCarthy Master Plan for the Port of Haifa. It was revised in 1953 and followed by the Kishon Development Scheme drawn up by Dutch consultants. The Master Plan and the Kishon Scheme determined the development of the port's internal structure to this day. Other aspects of port development, such as labour training, cargo and passenger handling, organisational problems, and administrative procedures were planned by the Port Authority's staff, ably assisted by foreign experts who visited the port from time to time, and also aided by experience gathered in study trips of senior staff members to ports abroad.

Development of the Port

The first phase of the Master Plan consisted of the construction of two deep water wharves in prolongation of the old main quay. The wharves were to give the port not only important new berths but also a badly needed additional reclaimed land area of 490,832 sq. ft. Construction on the two wharves started in 1952 and was completed in the spring of 1954. One of the wharves, 607-ft. long, with 36-ft. depth alongside, runs in line with the old main quay and will ultimately serve especially passenger liners and cruise vessels, once the new passenger terminal is completed. The other wharf, destined for bulk and general cargo, has the same depth but is 843-ft. long and recedes from the main quay line at an angle of 28 degrees to run nearly parallel with the main breakwater. Both wharves are built as a R.C. pile structure with a R.C. sheet pile retaining wall at the back and a 49-ft. wide R.C. apron that spans the piles and the retaining wall. The 18-in. x 18-in. piles and raked piles were driven to a penetration of up to 39-ft. when in clay. In areas where rock bed was encountered, composite piles were used, with wide flange H steel sections serving as pile tips. The concrete sheet pile wall was driven into an artificially created sand mound which was subsequently covered by a rubble slope of 1:1.5. The R.C. slab of the wharf apron was paved with 6-in. filler concrete which spans the hollows between the crane and railway rails. Water mains and electric cables that were to serve the wharves were suspended below the deck with outlet boxes running along the seaward end of the apron. The whole of the reclaimed area was asphalted, with the exception of the areas destined for the new passenger terminal and for transit shed No. 17. This shed was constructed on the 843-ft. wharf and put into commission in 1957. The shed is 453-ft. long and 230-ft. wide and has a 20-ft. wide covered loading ramp running along its landward side. The shed has three spans of about 75-ft. each, the outer two being formed each by a three-hinge R.C. transverse frame, the central span being made up of the cantilevered arms of those frames. The frames are spaced every 52-ft. of the length of the shed and are connected by Verendel precast R.C. beams which serve as supports to R.C. precast and prestressed joists and stringers, forming the roof of the shed. The shed is covered by asbestos-cement corrugated sheets, has walls of hollow concrete blocks and a floor of bitumen macadam, covered by a layer of Flintkote.

Most of the other targets planned in the early 1950's have meanwhile also been reached. Shallow water frontage has been extended by 1,174-ft. General cargo storage facilities were doubled by the construction of eight sheds and cargo turnover was speeded up by progressively staggered storage rates. One shed was transferred into a temporary passenger terminal.

Further wharfage and storage facilities were constructed in the new Kishon Auxiliary Harbour. Utilities were renovated and expanded and mercury lamps of sufficient candle power were installed to permit comfortable working of ships at night. Labour standards were raised by vocational training and its morale heightened by a decasualisation scheme which guaranteed the men minimum monthly wages. Take-home pay was also raised by the introduction of incentive wages, based on time-studies. Cargo handling was mechanised by the acquisition of mobile equipment to permit quick palletised load handling of uniform general cargo and by the construction of a grain silo and a potash loading plant for bulk handling of these commodities.

The European system of loading and unloading vessels by portal cranes rather than by ship's gear was adopted and 14 such cranes have been installed. Two powerful floating cranes of 100-ton and 25-ton capacity were acquired to handle heavy lifts.

The three contracting companies were made to merge and set up a unified command controlling the flow of cargo from ship to port gates. This removed bottlenecks, permitted optimum utilisation of labour, and cut down costs. The Port Authority also discontinued operating its own fleet of lighters, letting the port contractor alone provide this service.

A special port police, responsible to the Port Authority only, was set up and a system of joint tally at ship's side introduced so that the Port Authority's cargo control was extended right up to ship's rail. The port police and the joint tally soon made the port virtually immune from theft and pilferage.

Office work was completely revised and largely mechanised by the introduction of calculating machines and punched card equipment. Tariffs were simplified and management controls set up by an elaborate system of operational statistics and reports.

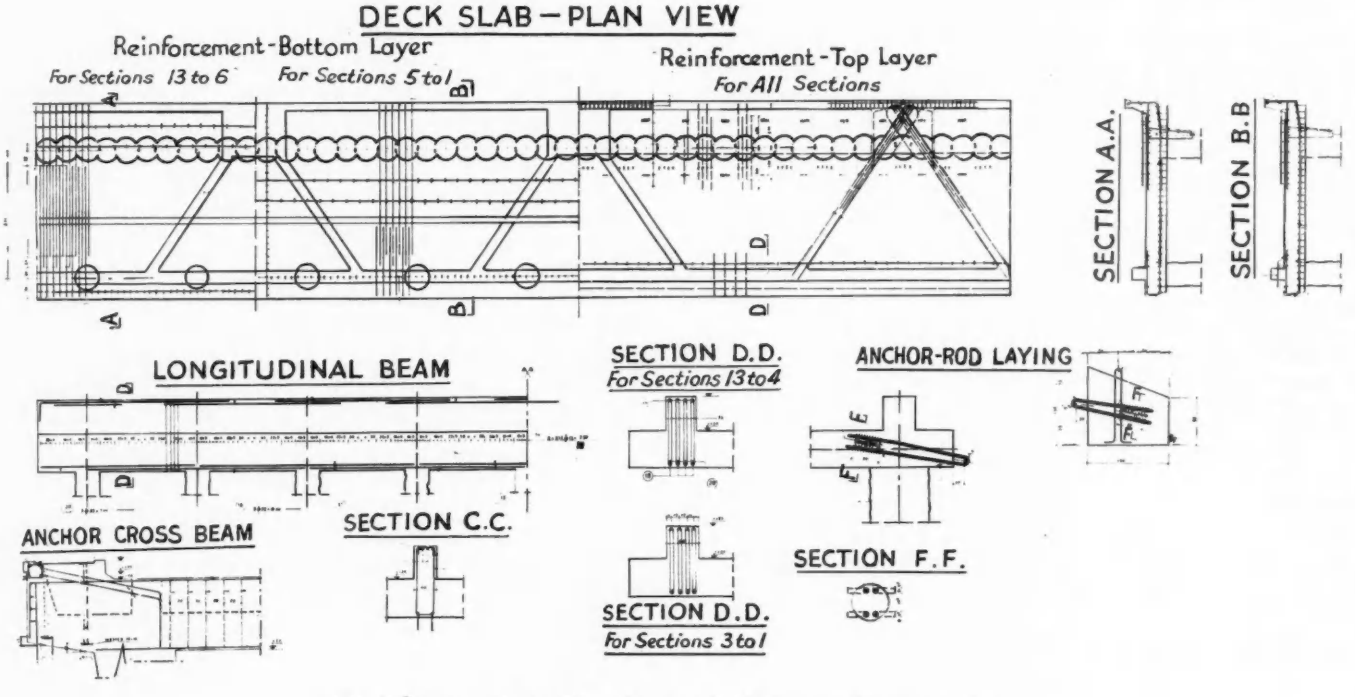
The port is now well equipped to accommodate general cargo freighters, bulk carriers, passenger liners and cruise vessels and to handle both general and bulk cargo. From six to eight vessels can simultaneously berth alongside the main wharves in depths ranging from 30 to 36-ft. Four more berths are available along the cargo jetty, two on each side. Additional berths are at hand along the main breakwater for ships unloading into lighters, or waiting for instructions or being laid-up. Four oil tankers of up to 18,000 tons capacity each can be accommodated within the oil dock, while larger tankers may berth at three submarine berths in outer anchorages. Three berths for medium-sized ships are also available in the Kishon Auxiliary Harbour.

As a rule, ships work to the quays or jetty. Less than 10% of inbound cargoes are worked overside into lighters from ships moored to the breakwater. Practically no outbound cargo is lightered.

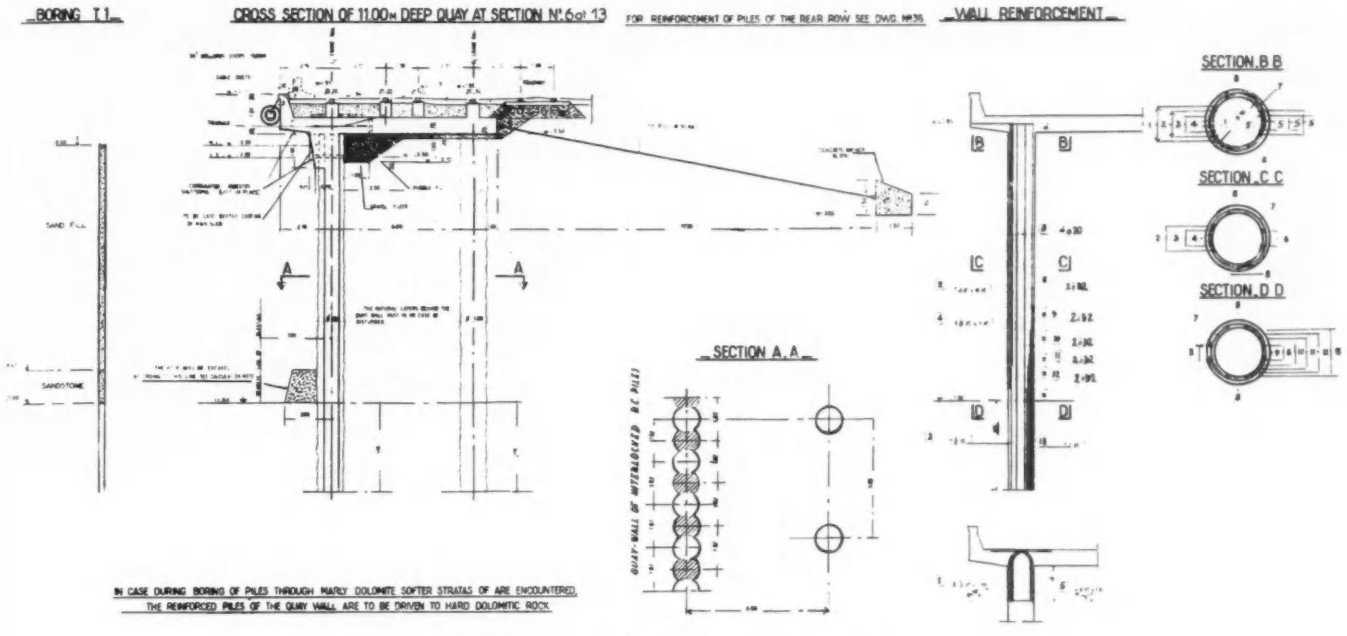
Handling of general cargo between ship and shore is either by ship's gear or by modern level luffing portal cranes of 3 to 5-ton capacity. Horizontal movement of the cargo from the quays to sheds or open storage places is done by tractor-drawn trailers or by forklift trucks which also deal with the delivery of cargo to and receipt from road and rail carriers, as well as the stacking and unstacking in sheds and open storage areas. Most of the packaged goods, such as bagged cargo, barrels, cartons, cases of citrus fruit, boxboard, etc. are handled on pallets both for loading to and discharging from ships and for stacking and unstacking in sheds. Some major export cargoes, such as cement in paper bags, fertilizers, plywood, and insulating boards are built up at the producing factories into palletized cargo loads and arrive at the port ready for loading.

The port's labour force includes some 1,700 trained stevedores, porters, operators of cranes, forklift trucks and tractors, lightermen, and workshop hands; a crew of 200 men who operate the grain silo; and the Port Authority's staff of 900, mainly warehousemen, talleymen, port police, maintenance staff, marine crews, and administrative personnel.

Apart from the 100-ton and 25-ton floating crane already mentioned, the port owns 14 modern level luffing portal cranes of 3-5 ton capacity on the main wharf, two portal cranes on the cargo jetty, one 5-ton portal crane on the old cargo wharf, and one 15-ton derrick on the heavy lifts dump near the main wharf. These heavy cranes are complemented by over 20 mobile cranes with capacities ranging between 2.5 and 30 tons. Other mechani-



Reinforcement of deck slab and beams of wharf now under construction.


BORING T 1
CROSS SECTION OF 11.00m DEEP QUAY AT SECTION N°6 or 13
FOR REINFORCEMENT OF PILES OF THE REAR ROW SEE DWG. N°35
WALL REINFORCEMENT
SECTION B B
SECTION C C
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IB
IC
ID
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SANDSTONE
IN CASE DURING BORING OF PILES THROUGH MARLY DOLOMITE SOFTER STRATAS OF ARE ENCOUNTERED,
THE REINFORCED PILES OF THE QUAY WALL ARE TO BE DRIVEN TO HARD DOLOMITIC ROCK

Cross-section of wharf now under construction.

cal equipment for general cargo includes 127 forklift trucks, 64 tractors, 921 trailers, 12 conveyors, and 15,000 pallets.

For the in-transit storage of general cargo, there are available in the main port 13 sheds totalling 538,559 sq. ft. floor space and in the Kishon Harbour two sheds totalling 75,347 sq. ft. Two further general cargo sheds in the main port, totalling 66,607 sq. ft. are at present employed by the Port Authority for its own use, while another shed of 34,121 sq. ft. now serves as a temporary passenger terminal. Open stacking areas total 684,044 sq. ft. in the main port and 176,527 sq. ft. in the Kishon Harbour. There are available in the vicinity of the port, but outside its area, commercial refrigerated stores totalling 1,483,333 cu. ft., capable of storing some 13,500 tons of goods. Fifty-six per cent of the storage area can be cooled down to −18°C. (0°F.) while 44% can be cooled below freezing point but not below −5°C. (23°F.).

Bulk Handling Facilities

The port has a modern silo for the loading, unloading, handling, and distribution of grain and seeds with a storage capacity of 42,000 tons. The silo's two pneumatic elevators have a combined maximum unloading capacity of 480 tons/hour ex vessel, with an effective average of 300 tons/hour. Delivery ex silo of the grain and seeds is bagged or in bulk, as required, at the rate of 350 tons per hour. The silo has technical appliances for cleaning, dust extraction, gas treatment, separating, mixing, drying, checking, weighing, and bagging.

Potash is stored in a 8,000-ton capacity shed built for receiving in bulk by mechanical means direct from railway hopper wagons at the rate of 70 tons per hour. From the shed the potash is fed by grab and a chain elevator to a belt conveyor which transfers the material across the port's main thoroughfare to a pair of chain conveyors mounted on fixed steel structures on the landward side of the potash berth. Each of these conveyors feeds one transverse horizontal chain conveyor which crosses the wharf on one of two mobile loading towers and transmits the potash to an ascending shipping chain conveyor, whose angle of inclination is adjustable to the height of the vessel. The two loading towers are mounted on pneumatic rubber tyres so that they may be wheeled off the quay on completion of the loading operation and leave the wharf unobstructed for the handling of other cargoes. Each tower serves one ship's hold. The loading installation has a total throughput of 100 tons per ship-hour.

For the storage of crude oil and heavy oil, there are available 34 tanks with a total capacity of 3,200,000 barrels at the Haifa Bayside Terminal of the local refinery. At the oil dock, there are another 16 tanks with a capacity of 900,000 barrels for the storage of heavy and light fuel oil, gas and diesel oil, kerosene and benzine. In the outer anchorage there are four submarine oil loading and unloading berths in water depths of 52-ft., each consisting of a submerged pipeline, of which only three of 12-in. diameter each are at present in operation. A fifth 32-in. diameter pipeline berth with a depth of 58-ft. is under construction and will be put into commission early this year. Vessels load or unload up to 1,000 tons per hour through 10-in/12-in. pipelines on the Oil Jetty, and up to 700 tons per hour at the existing submarine berths. The new 32-in. pipeline berth is planned for loading or unloading supertankers at the rate of up to 4,000 tons per hour.

Chemicals in liquid bulk, such as ketones, turpentines, acetates, alcohols, plasticisers, aromatic solvents, and detergent alkylates are unloaded, stored and distributed at a chemical tank farm and terminal in the Kishon Harbour, where tankers of up to 1,000 tons dwt. can be handled. The tank farm comprises 36 tanks of a total capacity of 109,463 cu. ft. which are connected to the unloading berth in the Kishon canal by 6 x 3-in. and 2 x 2-in. pipelines. The plant's pumping station contains 16 pumps of 126 h.p. in all, capable of unloading and loading vessels at the rate of 100 and 80 tons respectively. Another nearby plant operates facilities for unloading liquid gas from small tankers. The gas is then transferred by pipeline to a storage, filling and distributing station.

Passengers are cleared through a transit shed converted into a temporary passenger terminal. The terminal is equipped with the usual amenities, such as a refreshment buffet, bank and postal facilities, public address system etc.

Ship repair facilities include three yards capable of undertaking any repairs except those requiring dry docking beyond the capacity of the port's floating dock. This dock has a lifting capacity of 7,500 tons and can accommodate vessels of up 15,000 tons

dwt. It takes 90 minutes to lift the dock with a vessel weighing 7,500 tons. The dimensions of the dock are:

Length overall	518-ft.
Length on keel blocks	468-ft.
Width between side walls	79-ft.
Maximum depth over keel blocks	23-ft.

The port also owns a longitudinal type of slipway of 426-ft. length (410-ft. under water, 16-ft. above water) which can accommodate 500-ton maximum flat-bottomed vessels or deep-draft vessels measuring up to 150-ft. by 60-ft. Depth of water over blocks is 3-ft. for flat-bottomed vessels, and 8-ft. fwd. and 13-ft. aft for deep-draft vessels.

The fishing fleet is accommodated in the Kishon Harbour at the fish wharf, 700-ft. long, with 13-ft. depth alongside. Fish dock facilities include a building for the drying and repair of nets, mechanical repair shops, refrigerated stores, a market hall, office stores for dealers, and a gas oil station.

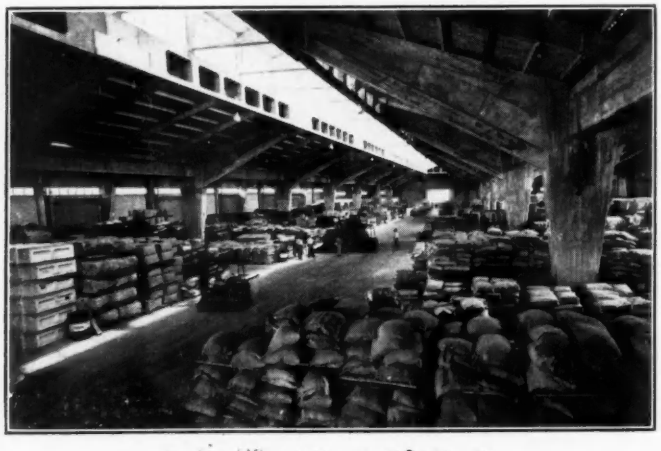
Dry Cargo Traffic Figures

In spite of the continual development of its facilities the port has found it difficult to keep pace with its expanding cargo traffic. The volume of dry cargo which had been a mere 473,000 tons in 1933 is now approaching the 3,000,000-ton mark. The following figures reflect the rapid growth of dry cargo traffic over the last decade:

	Cargo volume in 1,000 metric tons		
Year	Discharged	Loaded	Total
1950	1,110	182	1,292
1951	1,324	184	1,508
1952	862	208	1,070
1953	911	342	1,253
1954	1,058	549	1,607
1955	1,183	570	1,753
1956	1,145	662	1,807
1957	1,266	755	2,021
1958	1,320	678	1,998
1959	1,497	930	2,472
1960 ... ... (estimate)	1,650	1,030	2,680

While inbound cargoes increased only slowly during the last decade, at an average cumulative annual rate of 4 per cent, outbound cargoes have advanced at the remarkable average cumulative yearly increment of 18.8 per cent.

Three staple commodities—citrus fruit, cement and fertilizers—now account for 80 per cent of export cargoes, the remainder being made up of a wide range of agricultural and industrial products, such as fruit juices, eggs, hard wheat, edible oils, ground nuts, plywood, insulating boards, paper, bromine, asbestos manufactures, steel pipes, motor cars, etc.



Interior view of Transit Shed No. 17.

Arrival of citrus fruit by rail and lorries for shipment overseas.

One out of every five tons of export cargoes is delivered to Great Britain which leads the list of countries receiving cargoes through Haifa Port. Other main customers are the Netherlands, Germany, Rumania, Ghana, the U.S.A., Italy, Sweden, West Africa, Belgium, Turkey, and Yugoslavia.

Main import items are wheat, millet and soya beans which, together, account for 40 per cent of all imports, and then maize, barley, timber, boxboards, wooden logs, sugar, sulphur, iron plates, sheets and rods, pig iron, coal, coke, and machinery. Main suppliers are the U.S.A., Turkey, Finland, Great Britain, West Germany, Equatorial Africa, Belgium, Canada, the Netherlands, and Mexico.

In the main port, dry cargo traffic density is unusually high and runs at the rate of 1,600 tons per linear metre or 488 tons per foot of deepwater cargo quayage per year, excluding grain and potash which are both handled in bulk. If these two items are included the rate exceeds 2,000 tons per metre or 610 tons per foot per year.

The question has often been asked how the port can handle so heavy a load with apparent ease. The answer lies in part in the natural conditions of the port and in part in its organisational and operational set-up which has been specially adapted to the purpose. Ships can be taken in and out of the port at any time of the day since tidal fluctuations are negligible. Rain is limited to the winter months and even then comes in short spells that cause time losses rarely exceeding 5 per cent of available working hours in any one month.

By creating the Kishon Auxiliary Harbour, with its specialised accommodation for the fishing fleet, pleasure and sports craft, and, in the near future, also for all ship repair facilities, the main harbour has been relieved of a good part of its non-commercial functions, and been able to concentrate on cargo and passenger traffic.

The grain silo, in the main port, is worked all-around-the-clock, while general cargo operations proceed for 15 hours a day or longer, if required. The Marine Department works 24 hours a day, using the breaks in cargo work to shift vessels from and to working berths. To permit maximum utilization of water frontage, berths are not specialised but may serve any purpose. For that reason, too, none of the berths are leased to private companies for their own exclusive use. All wharves and general cargo sheds are available to the public at large on a "first come, first served" basis. Whenever a ship is not working, it is taken off the wharves and moved to the breakwater. Vessels are also often shifted alongside the wharves to squeeze in another vessel

View of the Main Port taken from the East Lighter Wharf.

or give a ship leeway to move out. Direct delivery from vessel to road and rail carrier and vice versa is encouraged whenever feasible and now averages 47 per cent of all general cargo. Those goods which must be stored prior to delivery remain within the port on the average for seven days only, since long-term storage rates in the port have been made prohibitively expensive. Stevedoring, lighterage and porterage operations are concentrated in the hands of a single contractor, resulting in complete integration of cargo handling and optimum use of available manpower. Much stress is laid on good labour relations. Dock labour is among the best paid in the country and feels financially secure, the majority enjoying permanent work contracts, with full pension rights, the remainder benefiting from a generous decasualisation scheme. Here again the happy circumstance that the port has only one labour union has contributed no little part to the smooth labour relations which are best gauged by the fact that the port has not had a single real strike to-date.

Administration of the Port

The vital role devolving upon Israel's only Mediterranean deep water port and the fact that its facilities are restricted within narrow limits also provide the rationale for the organisational and administrative structure of its port management. In view of its prime importance to the country, the port has since its construction been owned by the State. During the Mandate, port administration had been entrusted first to the Department of Customs, later to the Palestine Railways, both solutions ill-adapted to the port's obvious needs for a good measure of self-determination. In the State of Israel, the port was given larger autonomy but still remained a Government Department, called Port of Haifa Authority, under the Shipping and Ports Division of the Ministry of Transport. This is expected to change this year when the port will be integrated into an Israel Ports Authority, an independent body corporate with far-reaching legislative and financial rights to self-determination, similar to other autonomous Port Authorities elsewhere.

The Port of Haifa Authority is managed by a port director who is directly responsible for day-to-day managing, operating, and maintaining the port, and for advising the Ministry of Transport on matters of policy and port development. The port director is assisted by five senior executives, the port secretary, the harbour master, the head of the traffic department, the port engineer and the head of the security department, and, furthermore, by advisory staff. The port secretary is in charge of the entire port administration, which embraces accounting, budgeting, purchases and supplies of stores, personnel administration, secretariat and archives, publications, office systems and procedures, statistics, tariff policy, and co-ordination with other Government deparments, port contractors, and others operating in or connected with the port. The harbour master is responsible for the pilotage, mooring, berthing, and shifting of vessels in port, and also for fire fighting at sea and salvaging of vessels in distress. The head of the traffic department co-ordinates the discharge and loading of ships and lighters, the receipt, storage and delivery of cargoes and the clearance of passengers and their luggage. The port engineer is charged with the planning and supervision of harbour extension works, with the current maintenance of all harbour structures and installations that belong to the Port Authority, and he is also responsible for the operation of the floating cranes and the slipway. The head of the security department is in charge of the port police, the port gates, fire fighting ashore, and industrial safety. The staff include the legal advisor, the public relations officer, and the head of research.

All essential port services are given either by the Port Authority itself or by contractors under very close control of the Port Authority. The Port Authority provides the services of pilotage, mooring, berthing, shifting, fire fighting and ship salvage, all by its own craft and crew, but employs a contractor for the physical handling of cargo during all phases of stevedoring, lighterage, and porterage.

Two different systems are used side by side for receiving and storing cargoes. In the main port, the Port Authority itself receives imported goods at ships rail into its custody, stores them when required in its transit sheds, and loads them on to land carriers, *mutatis mutandis* for export cargoes. At the Kishon Harbour, transit sheds and stacking areas are operated by a private concessionary, who is responsible for the safe custody and delivery of the goods.

The basic structures, such as wharves, jetties and transit sheds, and all heavy equipment, such as tugs, the fire-fighting vessel, floating cranes, and the portal shore cranes are owned by the Port Authority. Bulk cargo handling facilities and mobile equipment for the handling of general cargo are owned and operated by the companies providing the cargo services.

The tight control of the Port Authority over all aspects of port operations and its constant endeavours to utilise to the utmost the limited port facilities have led to a marked rise in port operating efficiency. Stevedoring productivity in terms of tonnage output per gang-hour has been rising consistently during the last decade. Taking 1952 as the base year, because work was first put on an incentive basis as from 1953, the overall stevedoring productivity to-date, including the grain silo and potash plant, has risen by 52%, while productivity exclusive of these mechan-

Passenger traffic—some 100,000 passengers pass in and out each year.

ised plants has risen by 22%. Compared with the position at the end of the Mandate in 1948, overall productivity has risen by some 100%. At the same time it has been possible, by constant training of labour and by close supervision of work, to sharply reduce the incidence of dock accidents and of damage to cargo. Shipping turnround has also been speeded up so that the average time in port of incoming vessels from arrival to end of discharge was cut down from 7.1 days in 1950 to 4.3 days in 1958. In 1959, turnround time slowed down to 5.1 days and is still worsening in 1960. The reason for this reversal lies in the fact that the rapid growth of port trade has temporarily outpaced the development of its facilities. Work now on hand or in the final planning stage should ease the situation beginning with 1962. The main wharf is now being extended westwards over a distance of 1,732-ft. in continuation of the 843-ft. long new cargo wharf built in 1954. This length is made up of sections as follows: 797-ft. of 36-ft. depth, 771-ft. of 30-ft. depth, and 164-ft. of 16-ft. depth.

The Main Wharf Extension

Work on this important project is being carried out by the Compagnie Dunkerquoise d'Entreprises S.A., a French civil engineering firm, who were successful bidders for the contract.

The second Transit Shed in the Kishon Harbour under construction.

The construction design had to take into account the extremely difficult geological profile along the projected wharf line, where, within short stretches, the subsoil alternates abruptly between dolomitic rock, protruding up to 13-ft. above final dredged level, and clay pockets dropping down to 98-ft., with layers of marl, chalk or sandstone in between. To overcome these difficulties, the Compagnie Dunkerquoise d'Entreprises suggested an ingenious solution, based on the use of large diameter "Benoto" bored cast in situ concrete piles, which was accepted as being equally well suited for all foundation strata. According to this novel design, the quay wall is formed by interlocking bored piles of 3-ft. 7-in. diameter, each alternate pile being reinforced. The quay wall, together with a back row of single piles of the same diameter, which are bored into the original sea bed to rock strata at depths ranging from 15-ft. to 40-ft., maintain a 28-in. thick R.C. concrete slab.

The entire structure is connected by steel tie-rods to concrete anchor blocks. The area behind the new wharf will be sand filled with material dredged from the harbour basin in front of the wharf and will then be asphalted. A first stretch of the wharf, measuring 541-ft. in length, together with sea and land approaches is now ready for use and the remaining 1,191-ft. is due for completion by the end of 1961. The workshops and offices of the Harbour Maintenance Section, which are in the vicinity of the newly reclaimed area in the rear of the new wharf, will be relocated in the western end of the port, where some 1,350-ft. of special service quays will be built.

When the new wharf extension is completed, it will be provided with two transit sheds, one of 91,000 sq. ft., the other of 54,000 sq. ft. There has just been completed the first floor, with a built-up base floor area of 54,000 sq. ft., of a modern passenger terminal. The ground floor will be used as a transit shed and also for hold luggage. On the second floor passengers and their luggage will be processed while a mezzanine floor will contain a restaurant and visitors' galleries. The third floor will contain the offices and the lookout of the marine department as well as rooms for meetings and lecture classes. A plaza, level with the second floor, will serve as parking area for passenger cars and taxis. An overhead ramp will connect the plaza with Plumer Square near the Central Railway Station just outside the port fence. When this terminal is ready, the present passenger shed will become free and will revert to its original use as a cargo transit shed, adding 34,121 sq. ft. quay storage to the port's facilities. The grain silo's storage capacity, originally 20,000 tons, already enlarged in 1960 to 42,000 tons, is to be further expanded up to 69,000 tons, the work being expected to start in 1961. Facilities in the Kishon Harbour are also to be developed. The existing quay of 1,132-ft. will soon be extended by 935-ft. with a depth alongside of 26-ft. on which will be constructed a third transit shed of 43,000 sq. ft. It has meanwhile been discovered that the root of the Kishon breakwater on the seaside is being gradually eroded by the sea, threatening the stability of the breakwater. A survey is now being carried out to determine the size and contours of the needed shore protection. Still in the pre-design stage are plans for a water softening plant and an oil pollution cleansing plant, as required by the International Convention for the Prevention of Pollution of the Sea by Oil, 1954, of which Israel is a signatory. It is intended to set up this facility in the oil dock.

By the time the additional ship and cargo storage facilities become available between 1961 and 1963 the port will have at its disposal a total of 21 berths, not counting those at the breakwater, as under:

Existing main wharf	8 berths
Extension of main wharf	4 berths
Existing cargo jetty	4 berths
Existing Kishon Wharf	3 berths
Extension of Kishon Wharf	2 berths

Although six berths will thus be added to the existing fifteen, the new total of 21 berths will just cover requirements of alongside facilities. During the winter months in 1959 and 1960, a daily average of 16.4 vessels have been actually working cargo in the port, of whom 13.1 at deep water berths and 3.3 at the breakwater or at lighter wharves, while another 4 vessels were waiting for berths. This sums up to a total present requirement of over 20 berths, or 21 berths at least, if account is taken of cruise liners and large bulk carriers which require more than one berth to each vessel.

In terms of tonnage, the additional berths should bring the port's cargo handling capacity up to 3,200,000 tons of dry cargo per year. Israel's trade through her Mediterranean ports is expected to total 3,675,000 tons by 1965 and 4,450,000 tons by 1970. Subtracting the 500,000 tons of cargo the open roadsteads of Tel-Aviv and Jaffe can handle per year, Haifa should just be able to carry the 1965 traffic. After that, the new deep water port of Ashdod, 22 miles to the south of Tel-Aviv, is expected to replace the open roadsteads and to attract that part of the Mediterranean traffic which is destined for the southern and central parts of Israel. Haifa's share is now 85% of Israel's total trade over the Mediterranean border. This share should gradually decline with

Port of Haifa—continued

the expected development of Ashdod until, by 1970, the two ports will handle more or less the same percentage parts of the then prevailing cargo level. This will ease the work load at Haifa and give that port some much needed spare facilities.

Between 1948 and 1960, some IL. 37,200,00 at current prices have been invested in Haifa Port. Current operating surpluses have been sufficiently ample in the past and are expected to remain so in the future to cover debt service and depreciation charges on all the capital investments, past, present and contemplated. Future investments will be mainly required to solve four encumbrances which are seriously interfering with port work. The first of these is the lack of a special wharf for the handling of obnoxious cargoes, such as coal, sulphur, iron ores, phosphates etc. At present, these commodities are handled in the very heart of the port and the dust originating in the operation is blown over nearby passenger and cargo vessels, becoming a nuisance to the passengers and liable to contaminate other cargoes. The port is not large enough to solve this problem completely but it is thought that the construction of a wide deep-water finger pier at the western end of the harbour basin would provide enough relief to justify the cost of construction. Secondly, there is the formidable fire hazard of the oil dock immediately adjacent to the commercial harbour. Relocating the oil dock outside the port, somewhere off-shore the refinery, would make the port a safer place and also pave the way to the solution to the third of the port problems, the cargo jetty. The small width of this jetty, less than 48-ft., its limited maximum floor load which does not permit any addition to the existing two portal cranes on the jetty, and the depth of only 29-ft. alongside, make it obsolete and inefficient by modern standards. On removal of the oil dock, it will be possible to rebuild and merge the cargo jetty with the oil jetty by filling in the safety zone which now divides them, and thus create another wide eastern finger pier in accordance with present-day requirements. Finally, the railway lines, as laid out at present, cross at grade every road entrance to the port. The frequent train movements over the level crossings continually interrupt vehicular traffic to and from the port and often create traffic bottlenecks. The construction, in addition to the passenger overpass already mentioned earlier in this article, of two overpasses for vehicular traffic, one to connect the eastern part of the port to the town, the other to connect the western part, is considered the most economical solution to this problem.

Correspondence

To the Editor of "The Dock and Harbour Authority."

Dear Sir,

Rubber Fenders for Piers and Docks

We would refer to the article on pages 293-299 and, more particularly, to your Editorial on the above subject which appeared in your issue for January last.

In your comments you infer that, whilst rubber fenders are resistant to scuffing and abrasion, it is necessary that they are kept damp and shielded from strong sunlight to prolong their working life. As you probably know, we are one of the prime movers in this particular field with a wide range of experience over many years and virtually throughout the world and it is our finding that even under tropical conditions, sunlight and/or indeed extreme cold has no adverse effect on our fenders to any allowable degree.

Whilst realising that your Editorial refers to rubber in general, we feel that we should point out that your remarks do not apply to the particular compounds generally used for the manufacture of fenders, as obviously if a Design Engineer was under the impression that the fenders must be kept damp and shielded from sunlight this could have an adverse effect on his thinking and design.

Rubber fenders were first installed in American ports in 1933, at Colombo in 1935 and Madras in 1938. In the latter two ports the fenders are subjected to the most severe conditions of tropical sunlight and high temperature as well as high salt content sea water. They are also subjected to the usual contact with oil spillage as experienced in harbours.

After 15 years of continuous service, i.e. in 1950, a piece was cut from one of the Colombo Fenders and inspection showed that it had hardly deteriorated at all and this has been confirmed by independent chemical analysis.

The word "rubber" is used very loosely to describe products made of rubber whereas in fact there are many thousands of different compounding specifications which enable the base material rubber to perform specialised functions. For example, petroleum products are known to deteriorate rubber rapidly, yet specially compounded rubber enables hose to be manufactured for use on petrol pumps. Those hoses are kept full of petrol all the time and provided they are not damaged due to carelessness, they last between 8 to 10 years. The covers of the hose which are also made of rubber are compounded to withstand sunlight and abrasion and are also resistant to petroleum products. In service they last as long as the tube of the hose.

Similarly dock fenders are designed to withstand all the conditions which apply to the harbours of the world and have proved themselves to perform these functions economically.

Yours faithfully,

The Goodyear Tyre & Rubber Co. (Great Britain) Ltd.
17 Stratton Street, London W.1.
29th March 1961.

J. T. Perry.
Export Sales Manager.

To the Editor of "The Dock and Harbour Authority."

Dear Sir,

Cycloidal Propulsion, The Water Tractor

The Editorial note in your issue of February 1961 gives concisely and objectively the requirements for ship-handling tugs and weighs the merits and demerits of the screw propeller, shrouded and unshrouded, and the cycloidal Voith-Schneider Propeller.

As one who has been associated with the Voith-Schneider Propeller for the past 25 years, I would like to draw attention to a feature of the Water Tractor, viz. safety factor, which, as a Master Mariner, I consider to be of primary importance.

By positioning the propulsion unit in the forward part of the vessel and tow hook right aft, there is no possibility of introducing a heeling moment. This psychological security in the mind of the tug master, together with the ability to put maximum thrust for change of direction of the towrope pull, enables a pull to be applied much quicker than with the orthodox screw and rudder tug. So much for its effect on the towing efficiency.

From the absolute safety factor, the overall use of Water Tractors for shiphandling work would effectively eliminate the major cause of tug disasters through being girted or over-run. These are constantly occurring, there being three in the course of as many months last year in Great Britain alone, two with loss of life.

It is a proud boast that the sea is the safest form of passenger transportation. It should be our aim to make the life of the professional seamen in tugs equally secure.

Yours faithfully,

Estate Buildings,
South Road,
Weybridge, Surrey.
24th March 1961

E. C. Goldsworthy.

A Perforated Vertical Wall Breakwater

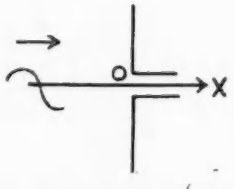
An Examination of Mass-Transport Effects in Gravitational Waves

By G. E. JARLAN
(Hydraulics Laboratory, National Research Council, Ottawa, Canada)

Introduction

The problem of wave reflection at a porous wall has been the object of exhaustive studies, particularly in acoustics. Stokes and Kirchoff investigated the motion of air in contact with a solid, taking into account the viscosity of the fluid and the effect due to heat. They arrived at the conclusion that in many cases sound penetrates porous bodies more freely than would be expected.

If a continuous perforated but flat, vertical wall is placed perpendicular to the direction of propagation of acoustic waves, part of the wave energy will be reflected while the remainder of the energy will be transmitted or dissipated through viscous friction and heat. The perforation may, for instance, consist of a series of uniform circular channels of a diameter much smaller than the wave length of the vibrations imposed. Viscosity and heat losses may be neglected in a simplified study of the characteristics of the reflected wave. If the origin of x is taken at the face of the wall, the one dimensional equation of the wave propagation may be written.[1]



$$a = \exp i\,(k_o x + n t) + B.\exp\left\{-i\,(k_o x - n t)\right\} \qquad (1)$$

where

$a = \exp i\,(k_o x + nt) = \cos(k_o x + n t)$ is the incident wave with $k_o = \frac{n}{c}$

c being the sound velocity in air and n the frequency.

The horizontal velocity component is given by

$$u = c\left[-\exp ik_o x + B \exp\left\{-i\,(k_o x - nt)\right\}\right] \qquad (2)$$

The ratio of u and a near the wall is found as a first approximation by putting x=0 in (1) and (2) so that

$$\frac{u}{ac} = \frac{B-1}{B+1}$$, B being the reflection coefficient.

For a thin wall, i.e. for a length of channel very small compared to the wave length of the perturbation, the mean pressures are approximately the same at both terminations of the tube. If σ_u denotes the area of the unperforated part of the wall and σ_p the area of the perforated part, one has:

$$-\frac{n}{k}\sigma_p = \frac{c\,(B-1)}{B+1}\,(\sigma_u + \sigma_p)$$

which gives the relationship between the inside and outside motion.

Using the continuity equation,

$$n\iint a\,d\sigma + K\iint u\,d\sigma = 0\,; \quad \sigma = \text{cross section area of the tube.}$$

the expression for B, as derived by Rayleigh, may be obtained

$$B = \frac{K(1+m) - K_o}{K(1+m) + K_o} \text{ with } m = \frac{\sigma_u}{\sigma_p}$$

where K is a function of n and c, of the channel radius r and of the specific heat of air. If one assumes $K = K_o$, then

$$B = \frac{m}{2+m}$$

for m=1, B=1/3, and the reflection is small.

These results suggest that a similar phenomenon, as far as the reflection is concerned, might occur when water is the fluid in oscillatory motion. Consider a chamber, one wall of which has a series of perforations equally distant from each other, placed in an infinite liquid of depth equal to its width. When the wave impinges against the perforated wall, part of the energy is transmitted through the circular holes, the rest being reflected or dissipated through friction at the solid boundary. The chamber

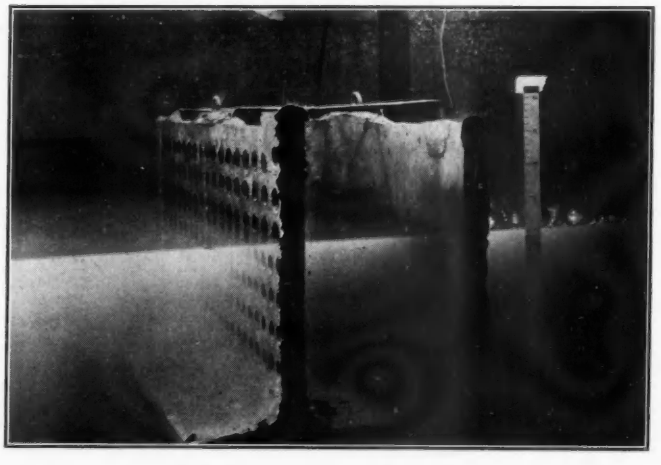


Fig. 1. Perspective View of the Perforated Wall Breakwater.

will then alternately fill and empty, the oscillatory motion at the perforated wall being gradually transformed into a mass transport through the holes which forces the liquid to arrive in the chamber in the form of jets. If H is the hydrostatic head corresponding to the maximum of the crest elevation at the wall, the velocity of the jet will be $v = \sqrt{(2gH)}$ if H is constant. The jet flowing from a pressure p_o to a pressure p_1 through an orifice of cross-section σ will be accompanied by a change of momentum in the direction of the velocity. It is difficult to analyze the jet problem if it is to be studied as a manifold flow with a certain number of holes being submerged only part of the time and where pressure fluctuations follow a harmonic law.

Mass Oscillation in a Tube

The flow in a single tube will now be examined, under the assumption that the motion is laminar and the hole always sub-

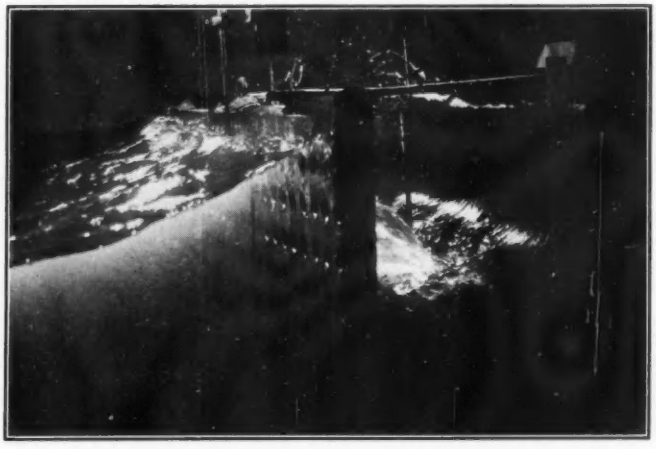
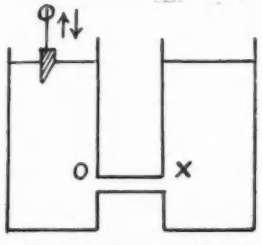


Fig. 2. Conditions inside the chamber at the beginning of the filling (t=0).

merged, using a simple device which will help to retain the physical principle involved in such a case. Two tanks filled with water, open at the free surface, are connected by a tube, sufficiently long with respect to its diameter. A plunger, subject to a harmonic motion, generates a forced wave in the tube. The system being initially at rest, the motion in the conduit results from the superposition of an oscillation proper to the system and of the forced oscillation. Experience shows that the first type of oscillation disappears after a while and that it is the forced oscillation which is of interest. The liquid oscillates in every point of the cross-section of the tube with a period equal to the one imposed by the piston. For a long and narrow tube, one may observe that a phase difference tends to occur in the motion of the liquid.



With O x representing the axis of the tube, the Navier-Stokes equation is written as

$$\frac{\partial V}{\partial t} = \frac{1}{\rho}\frac{\partial p}{\partial x} + \nu\left(\frac{\partial^2 V}{\partial r^2} + \frac{1}{p}\frac{\partial V}{\partial r}\right)$$

where V is the velocity component along O x, $\frac{\partial p}{\partial x}$ is the pressure gradient such that $-\frac{1}{\rho}\frac{\partial p}{\partial x} = A\cos\omega t$, r is an arbitrary distance on the radius of the tube and ν is the kinetic viscosity. V may be assumed independent of x if the tube is very long. The boundary conditions are simply V=0, r=R at the wall.

Sexl[2] obtained for V the following expression:

$$V=\frac{A}{\omega}\left[\sin\omega t - \sqrt{(R/\nu)}\exp\left\{-\sqrt{(\omega/2\nu)}(R-r)\right\}\sin\left(\omega t-\sqrt{(\omega/2\nu)}(R-r)\right)\right]$$

which shows that the velocity in the tube involves two terms of similar period and amplitude, out of phase by $\sqrt{(\omega/2\nu)}\,(R-r)$. A=wave amplitude. For $\sqrt{(\omega/2\nu)}\,R$ very large and neglecting capillary hysteresis, the relation gives $V=\frac{A}{\omega}\sin\omega t$. Hence, an axial symmetric mass oscillation takes place in which the velocity at the walls is greater than in the core (Richardson annular effect).

When the motion in the tube is turbulent, a jet forms outside the tube. It is presumed that the theory of wakes may be applicable to the case of the jet, completely self-preserving flow disappearing at a distance close to 50 diameters from the orifice.[3] The velocity distribution in the jet itself is important if one wants to study its subsequent diffusion within the liquid. Assuming the ratio of the Reynolds' shear stress to the mean velocity gradient to be constant, it is possible to use a velocity distribution similar to the one observed in a wake. This velocity distribution may be represented by an error function with appropriate coefficients. The study of flow establishment[4] shows that the entrainment of the surrounding fluid by the expanding turbulent region is inertially balanced because of a continuous reduction of the velocity within the jet itself. The shear exerted longitudinally as the jet occurs may be defined theoretically using the Prandtl concept of mixing length. Practically, it is impossible to measure the eddy viscosity coefficient within the jet. If the circular wall is not smooth, large eddy motion will take place originating from the action of forces normal to the wall which in turn will affect the eddy viscosity and consequently the velocity gradient.

Across the surface of the hole, there exists an average pressure from the incident gravity wave. This pressure acts as a driving force on the water in the hole, thereby causing variation in the level in the chamber. The flow in the tube being turbulent, the resistance coefficient to flow must be taken into account. Assum-

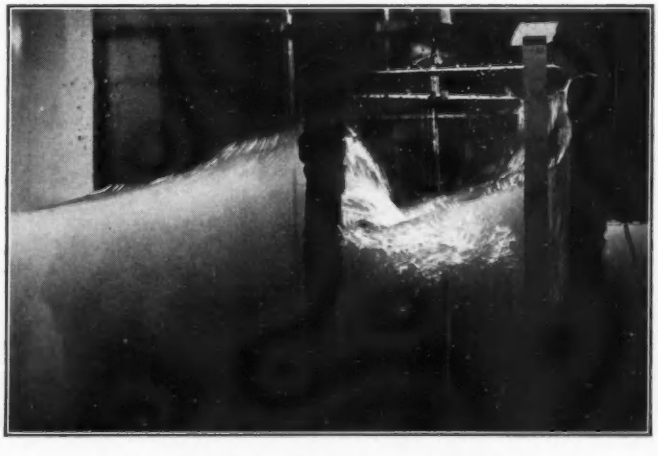


Fig. 3. Conditions of filling of the chamber at $t=\frac{T}{4}$ (T=wave period).

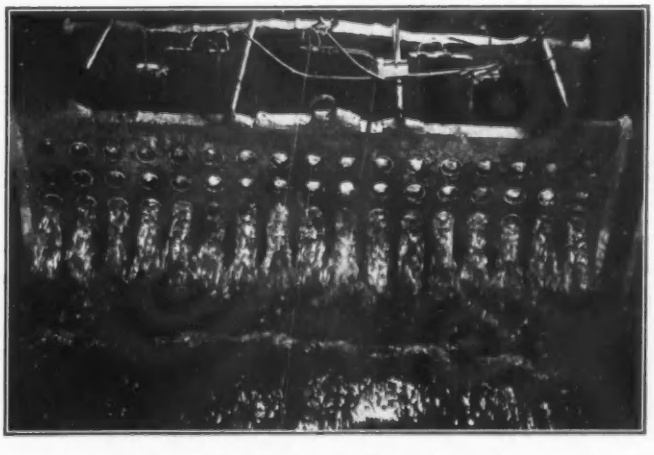


Fig. 4. Conditions of emptying of the chamber with the presence of a jump.

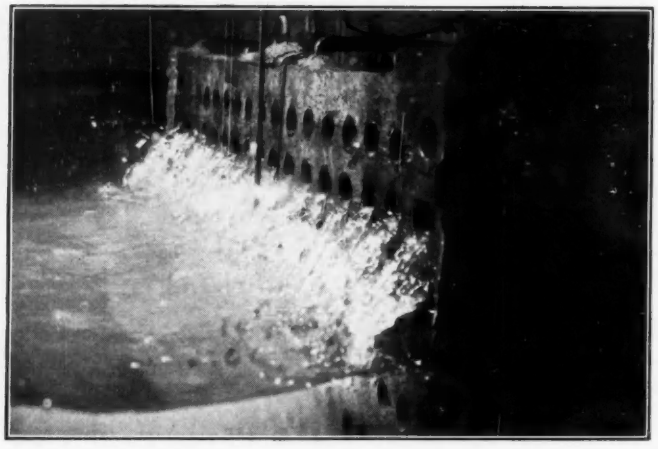


Fig. 5. Conditions of emptying of the chamber at $t=\frac{T}{2}$

Fig. 6. Conditions of emptying of the chamber at $t=\frac{2T}{3}$

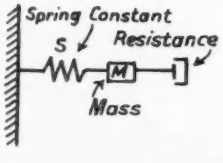
ing the head loss term to be of the form $\frac{fl}{D}\left(\frac{V^2}{2g}\right)$ the differential equation of the motion of the free surface in the chamber would be:

$$\ddot{y} + \frac{f(\dot{y})^2}{2D} + \frac{2gy}{l} = F\sin\omega t$$

where f=friction term, F=driving force, $\omega=2\pi/T$, l=a distance, y=vertical motion, D=tube diameter. This equation is not easily integrable because of the non-linear term but an appropriate solution can be obtained using series developments and Rieman integration methods.

In order to fix the ideas, simplification may be made whereby the above system may be represented by a mass-spring-resistance mechanical system subject to a harmonic driving force $F \sin \omega t$. The equation of motion is[5]

$$\ddot{x} + 2K\dot{x} + \omega_1^2 x = F_1 \sin \omega t$$



$$\omega_1^2 = \frac{S}{M}, F_1 = \frac{F}{M}, K = \frac{Z}{2M}, \omega = \frac{2\pi}{T}$$

A general expression for x is:

$$x = \frac{(F/M\omega_1^2)\sin(\omega t + \varphi)}{q} \text{ with } \varphi = \tan^{-1}\frac{2K\omega}{(\omega^2 - \omega_1^2)}$$

$$\text{The term } q = \left\{[1 - (\omega/\omega_1)^2]^2 + 4K^2\omega^2/\omega_1^4\right\}^{\frac{1}{2}}$$

is the magnification factor. Plotting q against ω, one obtains a tuning curve which shows that the high damping response is fairly flat. After a calculation of the appropriate coefficients, Z being a purely resistance impedance, it is possible to study the law of motion of the water level in the chamber.

Breakwater

A large amplitude gravity wave reflecting on a plain smooth vertical wall will create clapotis, the amplitude of which may reach 190 per cent of the incident wave height, the accompanying wave set-up being of the order of 10 to 20 per cent of the same wave. Thus, the pressures and subsequent dynamic loads exerted on the wall are important. The stream lines of the clapotis which approximately represent the trajectories of the water particles are such that the horizontal component of the motion at the node in the vicinity of the structure are very important. Consequently, this horizontal force will tend to exert in shallow water important shear stresses on the bottom. Erosion may then occur which could endanger the stability of the vertical structure. Moreover, the breaking of the clapotis is inevitable in shallow water and the subsequent elastic forces developing in the structure and in the joints is detrimental to good stability. A simple well-known rule may thus be inferred whereby a vertical structure must never be placed in shallow water.

One must then have recourse to rubble-mound breakwaters which dissipate the wave energy through mechanical friction in the porous medium, the amount of energy passing through the breakwater being very small for short-period waves.

However, in areas where no stone is available (and this occurs frequently in Nova Scotia or Prince Edward Island) the construction of rubble mounds involves heavy transportation costs having a noticeable bearing on final cost and maintenance budgets.

Consequently, it appears desirable to study the feasibility of prefabricating a caisson which would offer the same advantages as rubble-mound breakwaters but would not involve the disadvantages inherent to the use of vertical structures in shallow water.

In view of the above theoretical considerations, it was felt that a caisson with a perforated sea-side wall could be used as a breakwater, provided that it would not reflect waves to a great extent and assuming that it could be adequately designed to resist the dynamic loads exerted by waves.

Two-Dimensional Model Studies

To study the conditions of the reflection of the wave against a perforated wall a parallelepipedic chamber was built involving a plain vertical wall made of concrete to the scale 1/30 (Figs. 1 and 2). Tests were made in a two-dimensional wave flume, the equivalent prototype depth being 30-ft. The dimensions of the perforations were calculated in order to obtain a ratio m=0.49, the length and diameter of the holes representing about 1/100 of the wave length of a deep-water wave of period 8 seconds. The impedance of the holes is thus sufficient to ensure a noticeable phase shift between the wave motion outside the chamber and the fluctuations of the water level inside. The reflection coefficient was first investigated and it was found that this varied for non-breaking waves as a function of the wave camber, between 10 and 20 per cent. It was also observed that the phase shift between the maximum water elevation at the wall outside and inside the chamber varied from 50° for the small camber waves to 120° for high camber waves, the amplitude of the

Fig. 7. Conditions of emptying of the chamber at $t=\frac{3T}{4}$

fluctuations in the chamber being always smaller than the amplitude of the motion at the outside wall. These results are indicative of the effectiveness of the impedance for transforming the oscillatory motion of the liquid into a mass transport. The horizontal component of the velocity being largely reduced through jet diffusion, one mainly observes in the chamber a variation of head somewhat similar to the one which would be observed in a surge tank, although the damping conditions and the profile of the free surface are different here.

From this exploratory test series it can be inferred that the width of the chamber does not appear critical; in other words, the damping inside the chamber was sufficient so that no resonance, similar to the case of the Helmholtz resonator, could develop. The selection of the width of the chamber would thus appear to depend merely on the maximum wave camber occurring at a given site.

From the fluid mechanics viewpoint, the conditions of dissipation of the jet diffusing into a liquid mass subject to an oscillatory motion is a challenging problem and it is not known how much the dissipated energy dampens the energy of the incoming wave. The diffusion of energy into the liquid mass creates an extra turbulence near the wall which is prone to exert a damping effect on the wave front close to the perforated wall. It was also observed that as jets penetrated into the chamber, bubbles of entrained air were carried down into the water by the jet. The presence of this air should somewhat affect the damping characteristics of the vertical motion of the free surface in the chamber (Figs. 2 to 7).

Bed Movement

Observations in a two-dimensional flume showed that, as the chamber empties, a fairly intense current perpendicular to the wall is induced by the jets in the vicinity of the free surface. Although all holes involve a jet action, the latter is more important near the surface, which is to be expected. Hence, according to the principle of continuity, there exists a circulation which takes place in a vertical plane, with the existence, near the bottom, of a mass transport oriented toward the structure.

Some exploratory tests were run in connection with the transport of material under the form of a bed load. These tests showed that the material which penetrated inside the chamber was evacuated in the vicinity of the surface through the upper holes. The turbulence induced in the chamber by the jets appeared to be sufficient to permit the solid particles to be lifted by vertical upward currents taking place in the chamber. The material used in these tests was a fine sand of median diameter equivalent to 0.1 mm.

Remarks

The presence of this surface current would be an asset in areas where ice floes occur during storms since the drift induced by the jets would tend to damp the momentum acquired by the ice under the influence of combined wind and water stresses.

Run-up

Figs. 8 to 10 show a two-dimensional impact of a wave against a plain vertical wall, the incident wave height being the same as the one imposed for Figs. 2 and 3. It may be seen that the shape

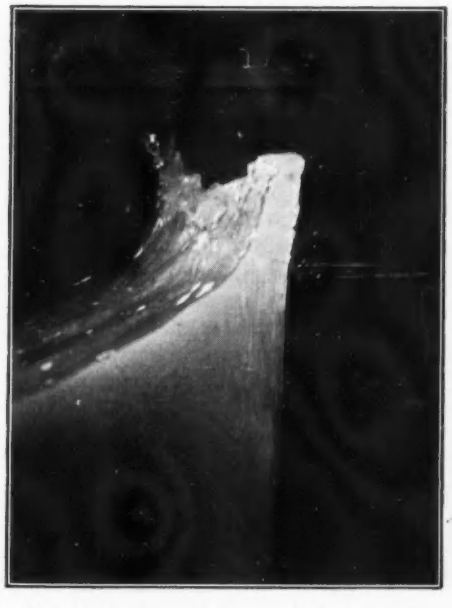


Fig. 8. Clapotis against a vertical plain wall, wave height 20-ft.

Fig. 9. Clapotis against a vertical plain wall, wave height 20-ft.

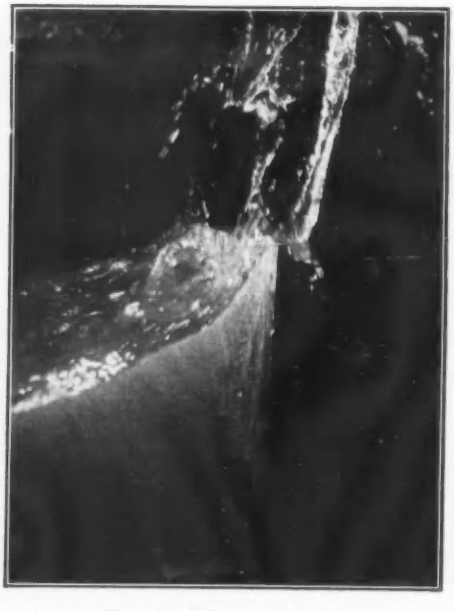


Fig. 10. Clapotis against a vertical plain wall, wave height 20-ft.

of the free surface is considerably different from the one observed in the case of a perforated wall. The tests showed that the run-up over the structure was not very large, even in the case of waves at the wall breaking partially.

Erosion at the Toe

Placing the structure on a rubble-mound mattress with natural slope, it was possible to observe that the stability of the mound was not impaired. No stones were displaced for wave heights of 15 to 18ft., the total depth of water being equivalent to 36ft. The average weight of the stone units was equivalent to 200 lb. No strong pumping action could be observed at the toe.

Combined Breakwater and Quay Wall

On the basis of the flume results it is feasible to conceive a structure which could be used as a combined breakwater and quay unit, as indicated in Fig. 11. Such a structure could be built 10 or 15ft. above the highest tides. There are clearly a number of structural problems which have not been considered in this note. It is evident that the design of a perforated thin shell must be made in order to take into account the resistance against dynamic bending and shear stresses. To make the structure sufficiently rigid, perforated baffles, regularly spaced, may be provided so as to allow a wave approaching the wall, under a given incidence, to fill the chamber in a more even fashion.

It will also be important to consider the peak pressures created by a wave partially breaking at the wall. Although such pressures are localized in the space and in the time, they may develop fairly intense impulses of the order of 100 to 300 p.s.i. lasting about 1/20 of a second. The problem of the joints between two adjacent breakwaters may be solved using perforated beams cast in place between the caissons and by providing a sufficiently long and narrow chamber behind them.

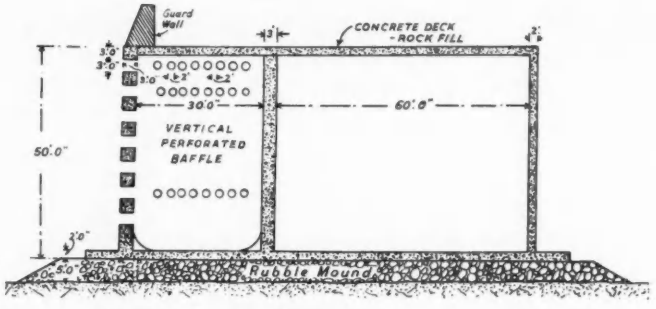


Fig. 11. Combined Breakwater and Quay Wall.

The Federal Department of Public Works of Canada has recently undertaken a feasibility study for a series of 100ft. x 60ft. x 55ft. caissons to be used as an extension to the existing breakwater of a harbour. If one uses as a criterion the combined cost of standard rubble-mound (or vertical jetty) breakwater and similar length of quay wall, plus maintenance costs, it would appear that the cost of a perforated wall structure is competitive, although different factors, depending on local conditions, may modify in one way or another the final estimates.

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Container Operation

Integrating Truck Services with Ocean Transport

The employment of containers is a subject receiving as much attention now as palletisation was a decade ago. It is, of course, another method of transporting goods in unit load form, which is attractive from both the economic and the practical points of view. The traffic and conditions in some countries—particularly where large quantities of loose packages have to be transported long distances on land — are more suitable for the container method than they are in others. Because of this, it is not surprising to see that the container concept is frequently discussed at United States meetings and conventions and that the use of containers has progressed a long way in that country. The American Standards Organisation has set up a committee to study and recommend suitable standard sizes and also methods of handling containers. In fact, in addition to an executive steering committee, four working sub-committees have been appointed to study the separate problems of pallet containers, cargo containers, van containers and the international co-ordination of American and foreign container sizes and practices. The American trucking associations themselves have in being a standardization committee to study the effect of the use of containers in their own industry.

Many aspects of the use of containers in land and sea transport —among them the economic, the handling, the pooling, the standardization and the effect on ship design—were discussed at an I.C.H.C.A. symposium on Modern Systems of Cargo Handling held in New York City last September. One of the papers was read by Thomas J. Thornton, Vice-President of Pride Transportation Inc., Brooklyn, New York, who, speaking, of course, from a truckmans' point of view, indicated "a realistic means of integrating the land-haul which is handled by truck into the system of ocean-borne containers. Interests concerned are, of course, the steamship companies, the railroads and the road transport organisations who, between them, have many different approaches which have grown up haphazardly."

Mr. Thornton's view outlined the case for a "consolidation terminal," away from the berth, where the contents of the road or rail transport vehicles would be transferred to containers, which would then be despatched to the pier. However, "Before discussing the actual operation of a consolidation terminal," he said, "I think it would be wise to point out the goals or aims of the steamship and trucking companies in this combined venture.

The steamship companies aim or desire is to cut down "turn around time" and the very burdensome labour cost that results. Likewise, the trucking companies have the same desire to cut down their "turn around time." The only way a highway motor truck or power unit can operate efficiently and economically is to keep its "wheels turning." Truck wheels that do not turn, but instead are motionless a good part of the time because of the loading or unloading function that has to be performed, result in an unnecessary heavy financial burden on the shipper, trucker, receiver and the eventual consumer of the goods. To be economically justifiable, a good axiom in this connection would be "the ship must sail" and "the trucks must move."

The term consolidation as we are using it will refer to shipments commonly referred to as LTL (Less than truck load) or LCL (Less than car load) or those shipments running in weight

up to about 10,000 lbs. Naturally, we are assuming large or container load shipments will move directly to the pier from the shipper.

Location of Consolidation Terminal

The determining factor logically should be nearness to the steamship pier, which would seem to dictate a location in Manhattan, Brooklyn, or Jersey City. The current crowded and congested conditions that exist in the metropolitan area with its small and narrow streets and tremendous delays, make it necessary to look elsewhere for available space for consolidation. The logical area would be in Maspeth, near Long Island City. There is still adequate space there and the Long Island Expressway links this area to midtown, New York City via the Queens Midtown Tunnel, the lower end of Manhattan via the Williamsburg Bridge, and a direct connection to Brooklyn via the Brooklyn Queens Expressway. For New Jersey, Hudson River Piers and Port Newark, N.J. terminals located between Jersey City and Port Newark, would seem to be the most logical.

With the contemplated development of the Port Elizabeth area, it would seem logical for the steamship companies to handle the consolidation themselves assuming that ideal conditions exist and this factor is taken into consideration in the new construction plans.

Development of New Stations

It would seem that existing trucking companies with their large consolidating and distribution functions would not have the space to perform such a specialized function. If economic conditions warrant it, the construction of new facilities designed specifically for this operation should be the goal.

A cross-platform operation would seem to be the ideal setup. As the delivery trucks unload on one side of the platform, the freight would be moved directly into the designated container on the opposite side of the platform.

As the containers are loaded, they can be pulled out by a switching tractor and an empty container can be placed in this location immediately. The loaded container could be dispatched to the pier at that time or could be held and delivered at a time suitable to both the truckman and pier.

This delivery option that is afforded brings up another problem that has plagued steamship companies for years. It has been historically true that the heaviest receiving period is the day before sailing. The days prior to this day are each successively less busy. A great many of the shipments on the last receiving day are small, but for nearly every one, an individual truck must be processed, moved to location, papers checked, unloaded, and then moved out. A single container load received from a consolidation station could carry as many as 15 or 20 shipments which would eliminate the necessity of that many trucks having to go to the pier.

It is true that the consolidating station likewise would be busy the day before sailing, but they would be able to handle the tonnage much more expeditiously because of better facilities.

With the tight control that a station of this type affords, the pilferage and damage problems can be reduced greatly.

This type of station because of its simplicity of design can be constructed at comparatively low cost.

Labour

We now come to one of the difficult problems to be solved and that is "labour." This problem must be faced. The ILA claims that if this consolidating function is performed away from the pier area, the right to handle this freight is theirs. The claim is that the freight is destined for overseas. Therefore, it is under their jurisdiction. On the other side of the fence is the teamsters' union who claims that until such time as the freight is delivered to the pier, the freight, whether delivered in containers or not, is work rightly belonging to them. Who is right? We, and the unions, can have different opinions in this matter, but one thing is sure. If it is economically feasible and justifiable, it is bound to come to pass. Progress can be hindered but it cannot be stopped.

Documentation Controls

Here is another area where savings can be made. The truck, when it arrives will present the dock receipts to the receiving clerk, who will give them to the broker. As the freight is moved into the appropriate container, it will be noted on a master manifest located at the rear door of the trailer. Upon completion of the loading of the shipment, the driver will present his receipts to the receiving clerk for necessary signature. When the trailer is completely loaded, a copy of the master manifest would be placed inside the container. The other copy of manifest would be turned over to the receiving clerk. This copy would then be photocopied and sent out through regular channels to the interested parties. If other documents are necessary, they would be obtained by using this manifest. It would seem the flow of paper work could be expedited, and at the same time cut down under this system.

Agency Agreements

The most logical approach to the problem of steamship-trucker relationship in consolidation would seem to be through an agency agreement. In this type of arrangement, the trucking company acts as the agent for the steamship company. This affords a much tighter control over the containers for the steamship company. With one trucker handling an area, insurance problems are also greatly reduced. It also affords the trucker the opportunity to obtain maximum use of his equipment, and eliminates dead running time. The shipper's own truck avoids the problem of long delays at piers.

Integration

Integration between all forms of transportation is what we should all strive for. Probably 5 to 10 years from now this will be accomplished. Because of the many different systems being developed, it does not seem to hold any hope for the immediate future. We are going through the trial and error period at this stage.

Future Potentials

The potential of containerization is tremendous for all forms of transportation. I think all will agree that it is a means of salvation for our merchant fleet. The most pressing problem in this area is standardization of the size of the containers. If this can be accomplished great strides can be made within a very few years. I can assure you the trucking industry as a whole is very conscious of the whole concept of containerization and will work hand in hand with other forms of transportation to see that its full potential is realized.

Port of Liverpool Appointment

The Mersey Docks and Harbour Board have appointed Mr. C. A. Dove, C.B.E., as Deputy General Manager and Secretary with a view to succeeding Mr. A. S. Mountfield as General Manager and Secretary in April next year. Mr. Dove is at present Chairman and General Manager of the Nigerian Ports Authority.

It is with great regret that the Board have had to consider the retirement of Mr. Mountfield owing to health reasons earlier than would normally have been expected.

Improvements to River Trent Navigation

Progress of Extensive Development Scheme

Work is nearing completion on a big scheme of improvement costing nearly £500,000 on the River Trent Navigation between Nottingham and Cromwell, some five miles below Newark. The scheme, launched by British Waterways just under four years ago, aims at removing bottlenecks and developing this important waterway which links the Humber ports and the Midlands.

The River Trent rises in the Staffordshire Hills near Stoke-on-Trent and flows via Burton-on-Trent, Shardlow, Nottingham, Newark, and Gainsborough, to Trent Falls, where it joins the River Humber and thence to the sea.

The Trent Navigation under the jurisdiction of the British Transport Commission extends for about 68½ miles from Wilden Ferry in Derbyshire to Gainsborough (Lincs.) where the River Trent then becomes an open navigation, the controlling authority being the Humber Conservancy Board.

For the first 8½ miles of its course from Wilden Ferry to Beeston Lock, the navigation consists of canalised river. At Beeston the navigation enters the Beeston Cut and the Nottingham Canal for about five miles of artificial waterway and joins with the main river at Trent Lock. For the remander of its course to Gainsborough the navigation consists entirely of canalised river. In the total distance of 68½ miles there are 13 locks including two flood locks.

The River Trent is tidal to Cromwell Lock, where the first of six large locks was constructed in 1911. Until 1951 there was a bottleneck at Newark formed by the single boat old Town Lock, and authority was obtained to construct a large four-boat lock alongside the old lock; this was opened in 1952. The River Trent Board have since completed a big flood prevention scheme at Holme, where large sluices have been built and a new river channel cut, dispensing with Colwick Weir, and Holme Flood Lock. As a result of these improvements craft 140-ft. long with a beam of 18-ft. 6-in. are now able to navigate up to Trent Bridge, Nottingham.

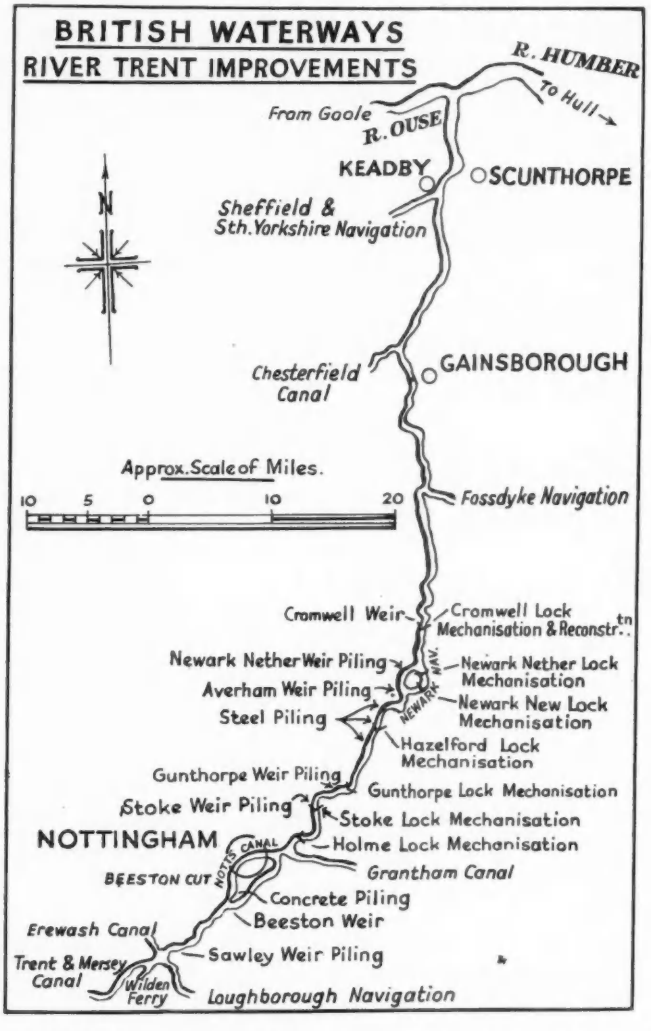
RECONSTRUCTION OF CROMWELL WEIR

Cromwell Weir, adjoining Cromwell Lock, was originally about 130-ft. long and was built of concrete in bags. It was outflanked on the right bank during the first winter following its construction and at intervals during subsequent years, and successive remedial measures gradually built up a long side weir. The side weir was again outflanked in January 1955 when extensive erosion of the right river bank took place. Emergency measures were taken to close the weir by dumping stone from barges, but the situation remained critical for some weeks. It was recognised that, although further remedial works could have been carried out to the existing weir, a lasting solution would be achieved only by a scheme of reconstruction on a larger scale than had hitherto been considered.

Messrs. Coode and Partners, consulting engineers, were therefore invited by British Waterways to prepare a scheme for the construction of a new weir, as a matter of urgency.

Trial borings on the site showed sand and gravel overlaying marl, the marl being found at about −1.0 O.D. (Newlyn Datum). The downstream water level varied from +10 O.D. at low water to +30 O.D. in severe floods. Essential requirements were that the flow from the new weir should not hamper river traffic approaching the lock from downstream, and that it should not cause silting in the channel leading to the lock.

Preliminary designs for a curved weir were tested at the British Waterways Laboratory at Bulls Bridge, Southall, Middlesex, and the River Trent Board also studied the design. The results of the tests were satisfactory, but it was found possible to shorten the weir slightly without detriment, by increasing its radius of curvature, and in the final design this was made 480-ft. The left abutment of the weir rested on the lock island, which was to be extended about 172-ft. downstream and the right abutment was



extended both upstream and downstream by training walls to an overall length of over 1,850-ft., to ensure that the river stayed in its channel. The training walls were to be faced with concrete slabs jointed with a bitumen-asbestos mixture. In order that not more than 40 per cent of the river should be closed at any one time, the River Board required that the new weir should be constructed in three stages and the height of the cofferdam piles above normal water level limited so that they would be over-

The new weir at Cromwell.

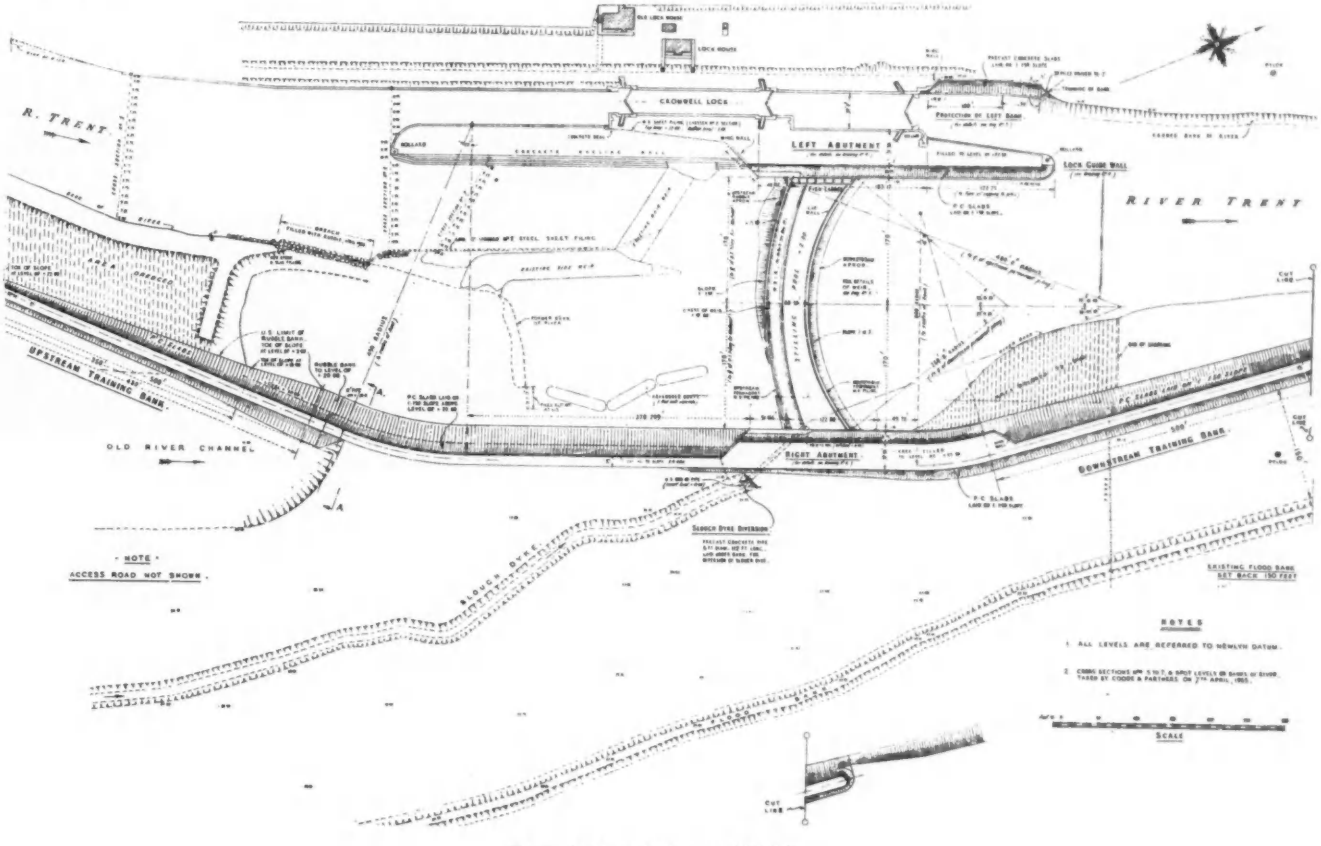
topped by severe floods. A fish ladder was required to a design approved by the Ministry of Agriculture and Fisheries. This is located adjacent to the left abutment and contains seven pools 10-ft. 6-in. x 6-ft., each with a vertical rise of 1-ft. 6-in.

A contract was placed with Messrs. A. Monk and Co. Ltd. of Warrington in August 1956 and work commenced immediately, starting with the construction of an access road to the site, approximately a mile long and of a type suitable for the movement of the heavy plant and materials required for the work.

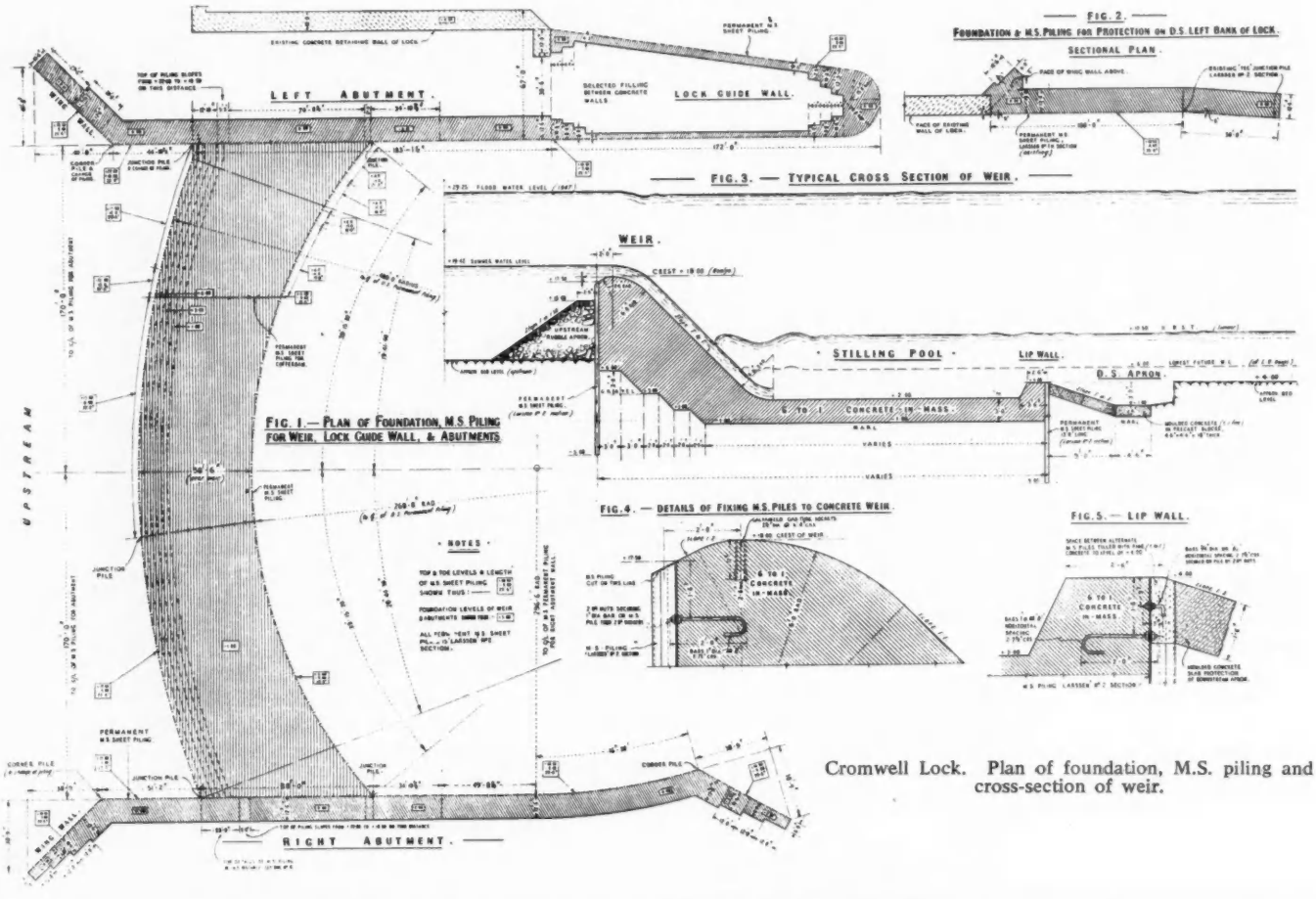
Steady progress was made despite difficulties arising due to flooding, particularly during the wet summer and autumn of 1958. The flooding was particularly troublesome during the most interesting stage involving the construction of the cofferdam for the third and final section of the weir, the section adjoining the lock. This involved closure of the river and its diversion over the two previously completed sections. A model of the contractor's proposed scheme was tested at the Research Laboratory and after certain adjustments pronounced satisfactory. The scheme was put into operation and proved quite successful. The works were completed in January 1959.

CROMWELL LOCK EXTENSION

Cromwell Lock, the lowest lock on the River Trent, is situated five miles downstream of Newark, at the limit of tidal influence. The lock, as built in 1911 by the former Trent Navigation Company, had two pairs of gates and was 187-ft. long between hollow quoins and 30-ft. wide. It accommodated four standard Trent barges or one large oil tanker, but was not deep enough to pass craft through at all downstream water levels. To alleviate the congestion of traffic which occurred below the lock during periods of drought and prolonged low water level, a third pair of shallow gates was built some twenty-five years ago below the lock tail, to form a "two rise" lock for raising and lowering vessels in two stages. In practice the arrangement was not very satisfactory and to overcome the delays which occurred, and to avoid the high cost of building a second lock alongside the existing one, it was decided to replace the third pair of gates with deep gates, extending up to cope level, in a new gate chamber. The lock thus lengthened would enable eight standard barges or three large oil tankers to pass through in one locking operation, when the downstream water is at or above normal level, and in periods when it is



General plan of Cromwell Weir.


LEFT ABUTMENT
LOCK GUIDE WALL
RIGHT ABUTMENT
WEIR
STILLING POOL
LIP WALL
D.S. APRON
UPSTREAM
FIG. 1. — PLAN OF FOUNDATION, M.S. PILING FOR WEIR, LOCK GUIDE WALL, & ABUTMENTS
FIG. 2. — FOUNDATION & M.S. PILING FOR PROTECTION ON D.S. LEFT BANK OF LOCK. SECTIONAL PLAN.
FIG. 3. — TYPICAL CROSS SECTION OF WEIR.
FIG. 4. — DETAILS OF FIXING M.S. PILES TO CONCRETE WEIR.
FIG. 5. — LIP WALL.
NOTES

Cromwell Lock. Plan of foundation, M.S. piling and cross-section of weir.

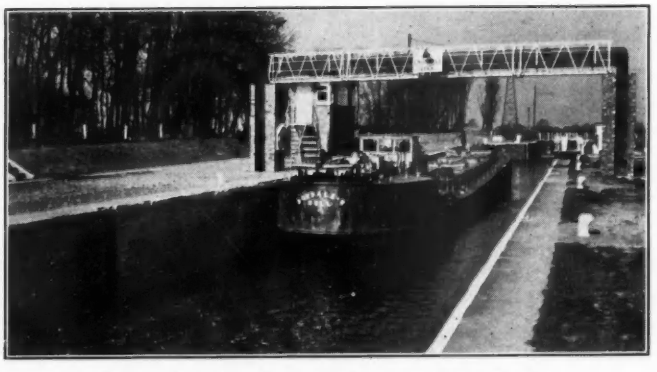
below normal, two large oil tankers would be able to pass at one time.

It was essential that there should be as little interruption as possible to traffic during the lengthening of the lock, and, when tenders for the work were invited, it was made a condition that the only lengthy stoppage would be for a period of eight days at the beginning of August 1960.

In March 1960 a contract was placed with Tarslag Ltd., of Rotherham and work commenced forthwith.

The two side walls of the new gate chamber were constructed consecutively in steel piled cofferdams, and as each cofferdam in turn projected into the waterway, access to the lock was restricted somewhat. Special care had therefore to be taken by navigating vessels, but, in fact, very little difficulty was experienced. In accordance with the pre-arranged schedule of work, the lock was closed to traffic at midnight on July 30th and work proceeded continuously with day and night shifts. A steel sheet-piled dam at the downstream end was closed and the excavation for and concreting of the invert undertaken. A pair of steel gates, fabricated by the Consett Iron Co. Ltd., which had been brought from Consett by road to the site, was lowered into the lock chamber and placed in position. Traffic through the lock re-started on August 8th.

The left bank of the river downstream of the new gate chamber was trimmed back to a 2 to 1 slope and faced with stone pitching up to normal high water level. In front of the bank, three dolphins were constructed, to which vessels waiting to enter the lock can moor. Each consists of four steel box piles strongly braced with steel members, and with a heavy reinforced concrete cap.



Cromwell Lock after extension and mechanisation.

LOCK MECHANISATION

One of the principal features of the scheme is the mechanisation of seven main locks which will not only minimise the considerable physical effort involved but will cut the time taken by about half and so speed the movement of traffic. Already the locks at Newark Town, and Cromwell have been mechanised, and two more—Newark Nether, and Gunthorpe—are nearing completion. It is hoped to start work on the remaining three — Hazleford, Stoke, and Holme—later this year or early in 1962. The mechanisation of other locks through which a heavy flow of traffic passes is being planned.

The obvious advantage of the mechanised operation and control of the lock gates and sluices over the slower and laborious operation by hand gear is that a quicker passage of vessels through the

lock is obtained.

The system of operation and control adopted on all locks mechanised, or in progress, in the North Eastern Division of British Waterways is the Oil Hydraulic Power System in which oil is pumped to a relatively high pressure (1,000 lbs. per sq. in. in the case of mechanised locks) and the hydraulic power is taken through pipes to the point of application where it is converted to mechanical power, generally by a ram or piston where the force is required in a straight line, and by a fluid or hydraulic motor where rotary motion is required.

In the lock mechanisation scheme the pressure pumps are driven by electric motors located in a pump house, generally built underneath the control room which houses the control panel, switches for the operation of signal lights for regulating the entry of vessels into the lock, and a telephone.

The control levers are self-centering in the neutral position and movement of the levers one side of the central position controls the opening of the gates or sluices and movement the other side controls the closing of the gates or sluices; only the slightest effort is required to operate the levers which are almost 6-in. long.

The pipes carrying the hydraulic power from the pump house and control room to the points of application at the lock gates and sluices have been specially wrapped with compounded tape to prevent corrosion and are generally laid in concrete troughs sunk into the ground and covered with concrete slab covers, thereby providing easy access to the pipes for inspection and for attention should the need arise.

Three basic designs of machines have been developed and standardised for the operation of lock gates and sluices.

(1) Gate Operating Machines

There are two leaves to each set of gates; some locks have two sets of gates and some have three sets.

Each gate operating machine opens and closes one gate leaf by means of a 4-in. dia. x 72-in. stroke double-acting hydraulic cylinder, the force being applied through the piston rod to a crosshead moving in cast iron guides and from the crosshead, through a tubular connecting rod to a suitable point in the gate leaf.

The connection between the crosshead and the connecting rod is of the ball and socket type to allow for any vertical or horizontal movement in the gate.

The hydraulic cylinder, crosshead guides and all associated equipment are securely mounted on a heavy fabricated base which is bolted to a concrete foundation block.

(2) Sluice Operating Machines (for Sluices Mounted in the Gates)

The gate mounted sluices are operated by a 4-in. dia. x 27-in. stroke double-acting hydraulic cylinder flange mounted vertically on a tubular stand, the $5\frac{1}{2}$-in. dia. bore of which serves as a guide for the crosshead attached to the end of the piston rod. A connecting rod with ball and socket connection to the crosshead transmits the applied force to the sluice gate or door, which is of the vertical slide or penstock type. The hydraulic power is taken from the pipe at the lock side to the fixed pipe on the lock gate by means of a high-pressure flexible hydraulic pipe.

Examples of this type of mechanism can be seen at all the locks which have been mechanised on the River Trent.

(3) Sluice Operating Machines (for Sluices in Culverts in the Lock Side Walls)

These sluices are of the horizontally pivotted butterfly type, the largest size have an opening approximately 7-ft. x 4-ft.

The sluices are operated by a 4-in. dia. x 42-in. stroke double-acting hydraulic cylinder which is pivot mounted at the closed end and the piston rod is pin-connected to the downward arm of a 90° bell-crank mechanism. The other arm of the bell crank is pin-connected to a long connecting rod at the other end of which is a pin connection to a bracket on the sluice door. Incorporated in the bell-crank mechanism at Cromwell Lock is a cam operated hydraulic valve which provides a variable rate of opening of the sluice to limit the velocity of the water leaving the culvert.

The machine is mounted on a heavy fabricated base which is bolted to a concrete foundation block. An example of this design of mechanism can be seen at the bottom gates of Cromwell Lock.

In the case of one lock on the Aire and Calder Navigation, fluid or hydraulic motors have been used to operate the type of sluice through gearing and a rack and pinion but the hydraulic cylinder and bell-crank mechanism appears to be the better method for this purpose.

As a safeguard against the failure in the supply of electricity from the mains standby diesel generators or hydraulic pressure pumps have been provided.

Concrete Caisson Gate for Dry Dock in Hamburg*

The "Elbe 17" dry dock, in the Port of Hamburg, is the largest in Europe. In 1959 this dock was reconditioned and fitted with a new caisson type gate with an overall length of 62.60 m., a moulded breadth of 13.60 m., and a depth of 15.01 m. from coping to cill. It differs from the conventional caisson in being constructed of reinforced concrete instead of steel.

The caisson contains fifteen water ballast compartments. To flood these compartments, water is admitted into the structure through two lateral inlets and is distributed to the various parts of the caisson through a system of pipes. Emptying the compartments is effected by two independently driven pumps installed on either side of the caisson, beside the inlet openings.

The electric motors for driving the dewatering pumps, and those for actuating the distribution valves and the inlet and discharge valves, are installed on the intermediate deck of the central ballast compartment. In an emergency, all the valves can be operated manually. The central switchgear which controls all the electrical equipment is accommodated in a switchroom above the motor room, while the control cabin itself is placed at the top of the caisson, at the level of the footbridge.

The caisson is moved into position across the dock entrance, or removed from that position, with tug assistance. To close the entrance, the caisson is manœuvred up against the jambs, and is secured by hawsers to bollards on the pierheads on either side of the entrance. When the caisson is in this position, flooding of the ballast compartments commences. At the same time, the dock dewatering pumps are started. This causes water to flow under the caisson into the dock and produces a certain pressure on the caisson, forcing it against the jambs. As the caisson sinks deeper, the opening between it and the dock floor becomes smaller, so that the water rushes in at a higher velocity. The pressure exerted on the caisson thus increases progressively, and when the base of the caisson reaches the bottom, the pressure goes on rising in

*Based on an article by W. Niermann in "Schiff und Hafen," No. 11, 1959.

Caisson Gate for Hamburg—continued

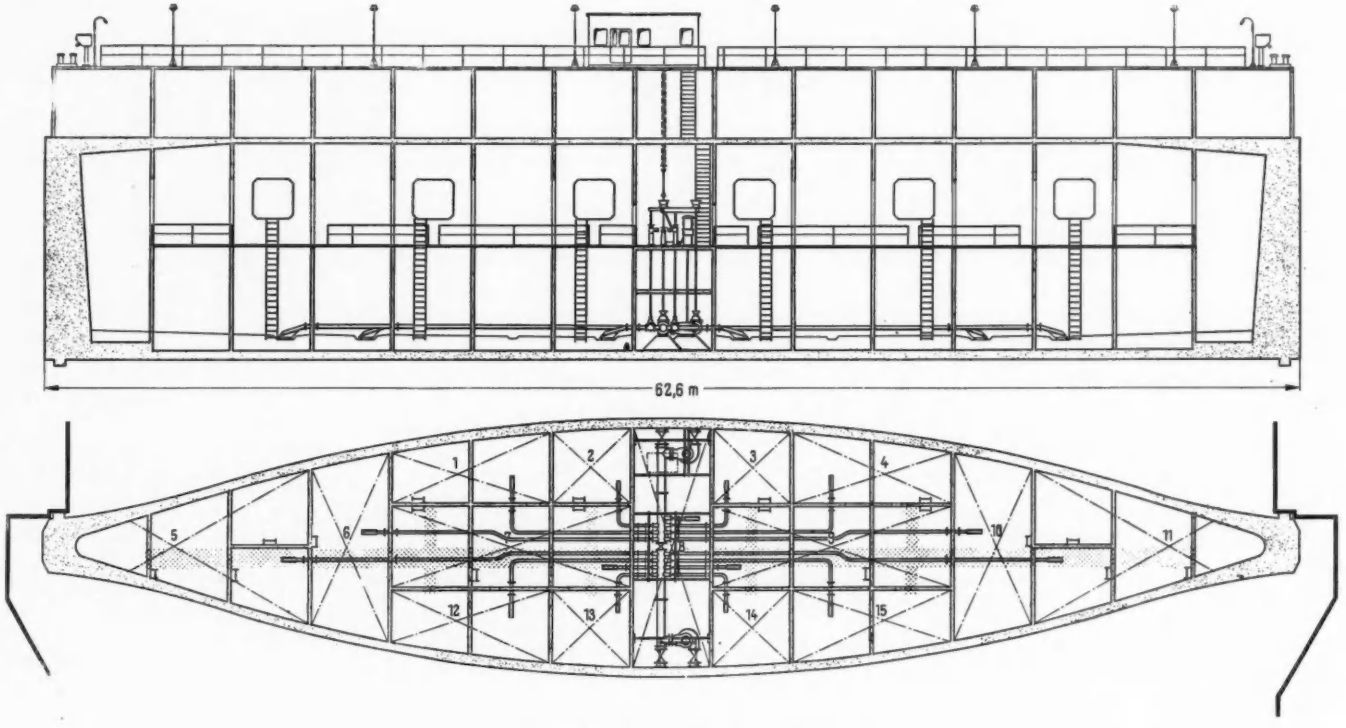


Fig. 1. Longitudinal Section and Plan of Caisson.

consequence of the increasing difference in the level of the water inside and outside the dock.

The meeting faces are formed by timbers provided with inserted tubular rubber gaskets for obtaining a perfectly watertight seal.

The empty caisson, i.e., without water ballast, weighs about 4,500 tons. The overall structural rigidity is ensured by stiffening bulkheads in between the compartments. For a draught of 11 m. and a freeboard of 0.50 m. the water displacement is about 6,000 m³. The draught of the empty caisson is 8.20 m. It takes about 300 tons of water ballast to sink it. The sinking operation takes 6 minutes to accomplish. To compensate the tidal difference of 2.30 m. in the Port of Hamburg, 950 tons of ballast are additionally required, so that 1,250 tons are needed in all. To produce adequate pressure of the base of the caisson on the dock bottom so as to ensure a suitably watertight joint, the caisson is flooded with a total of 2,066 tons of water, thus producing a load of 816 tons on the base. The dewatering pumps each have an output of 1,000 m³/hour, so that, if both pumps are working, it takes about one hour to dewater and float the caisson.

The control equipment for the dewatering pumps and the various valves is laid out on a desk type panel which is surmounted by an illuminated mock-up layout of the caisson. This control panel, which is also equipped with indicators showing the water levels in the compartments, gauges for registering the trim of the caisson, and various other devices is accommodated in the control cabin at the top of the structure.

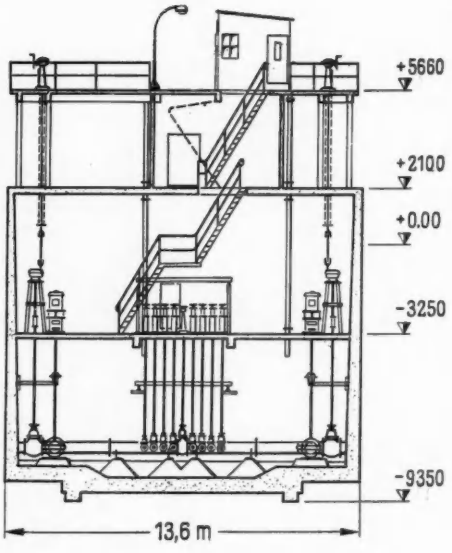


Fig. 2. Cross-section through Caisson.

On the mock-up layout each ballast compartment is represented by an illuminated area which lights up in white when the distribution valve of that particular compartment is closed; when the valve is opened, the colour of the light changes to red. The "open" and "closed" positions of the valve are determined by limit switches installed in the valve actuating circuit. In the event of failure of a valve to reach its appropriate limiting position, a warning lamp lights up at the control panel.

The dewatering pumps are vertical-spindle double-entry centrifugal pumps capable of delivering 1,000 m³/hour against a head of 8 m. They are each driven by a squirrel-cage type three-phase motor with an output of 44 h.p. at 965 r.p.m. The motor is connected to the pump driving shaft through a flexible coupling.

The top deck of the caisson forms a wide footbridge, which is lighted at night by fluorescent lamps mounted on curved standards. The interior of the caisson is provided with a walkway giving access to the various compartments.

Simplification of Shipping Documents

The third session of the Council of the Intergovernmental Maritime Consultative Organization (IMCO), which was held in London early last month agreed to support the simplification of shipping documents. A report entitled "Reducing Shipping Paperwork" was released at the meeting for distribution to all member nations of IMCO.

It was also agreed that the International Chamber of Commerce should be requested to act as its civilian advisory organ.

Development of Durban Harbour

Extensive Modernisation of Harbour Facilities

The revival of trade in the immediate post-war years and the consequent increased flow of both import and export traffic resulted, at intervals, in the bunching of ships and congestion of cargo at South African ports. To meet this situation and also to provide for the larger ocean-going liners that were expected to call in the future, the South African Railways Administration took steps to bring the facilities at the harbours into line with the enlarged carrying capacity of the railways and with present and future trade requirements. The plans provided for harbour improvements, including mechanisation, to cost an approximated £33,000,000 during the sixteen years' period 1946-1962.

The facilities which were available at Durban harbour during the war years proved of inestimable value. Battleships and other craft were repaired, re-fitted and provisioned, and Salisbury Island, within the harbour area, became an important naval base. The demands of peace were, however, no less insistent than those of war and it became necessary to plan further harbour extensions in order to meet the challenge of the country's expanding economy. The tonnage of goods handled at Durban, for example, has nearly doubled in the past ten years while the quantity shipped increased by a third.

In addition to the provision of extra and more up-to-date mechanical handling appliances and floating craft, the following works of a major nature have been undertaken:

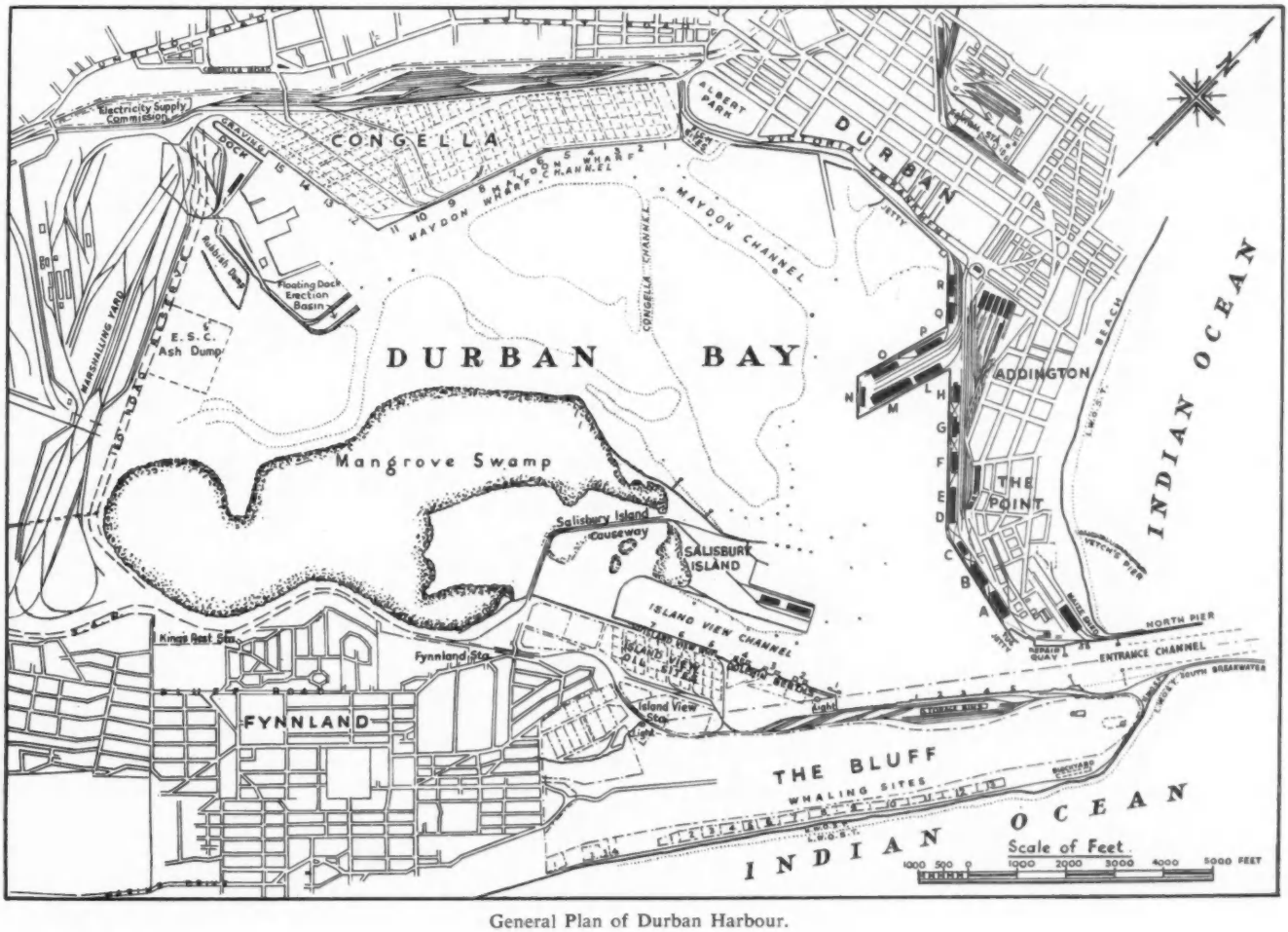
(1) Replacement of cargo sheds at "D" and "E" berths.
(2) Provision of new cargo sheds at "L" and "M" berths, "T" jetty.
(3) New passenger terminal at "T" jetty.
(4) Additional pre-cooling facilities at "T" jetty.
(5) Widening and deepening of Island View channel and Turning basin.
(6) Tanker berth at No. 7 berth, Island View, and provision of additional tanker berth at No. 8.
(7) Replacing of timber wharves by steel.
(8) Linking up of berths 10 and 12, Maydon Wharf.
(9) Ship repair berths.

In 1946 the harbour had 25,646-ft. of deep water commercial wharfage as compared with 29,882-ft. at present, an increase of 4,236-ft. The cranes have been correspondingly increased from 79 to 101. In addition to which, eighteen 4-ton and two 15-ton cranes, at present under construction, must be added while authority has been given for a further twenty-three 4-ton cranes.

Point Area

Two timber constructed cargo sheds at "D" and "E" berths have been demolished and replaced by one combined modern shed. The new structure covers an area of 120-ft. x 750-ft. and is of the latest steel design with brick panels between concrete columns.

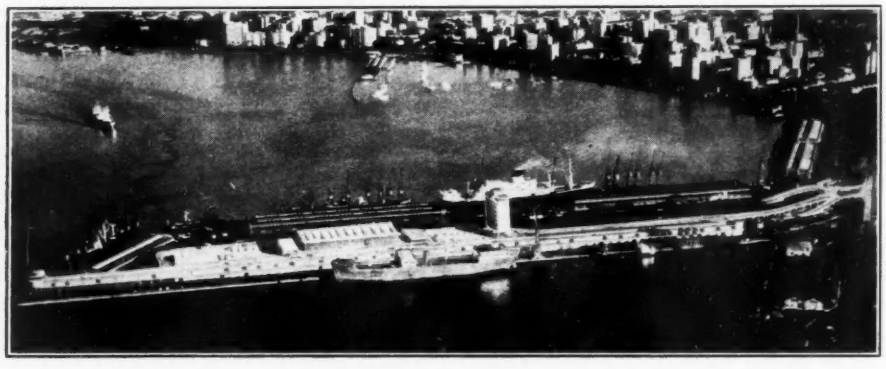
The construction of the "T" jetty which was started in 1936 was completed in 1942 and provided the Point area with an extra 5,029-ft. of wharfage. On its completion, "L" and "M" berths were not provided with shed accommodation and the space occupied by these berths was used generally for



General Plan of Durban Harbour.

ship repair work and also to meet the berthing of cargo ships at rush periods.

In recent years the necessity for better passenger facilities became evident and an extensive programme is at present under way to provide these and other improvements which will be in operation by March, 1961. The entire project comprises a 600-ft. x 120-ft. cargo shed at "L" berth, of reinforced concrete construction with prestressed beams spanning a width of 85-ft. and providing a cantilever cover of 27-ft. over the rail siding running the full length of the shed. The roof of this shed is constructed of precast panels 24-ft. x 4-ft. and provides parking for 300 vehicles. An overhead roadway spanning all service lines provides uninterrupted access to the parking area. A shipping gallery extends the full length of the shed on the water side and lines up with the future passenger terminal and pre-cooling store at "M" shed on the adjacent berth.



An artist's impression of the new Ocean Terminal superimposed on a picture of the "T" Jetty.

The shed at "M" berth will be a three-storied brick-faced building on the outer end of the jetty. The ground floor with a floor space of 900-ft. x 120-ft. will consist of an airlock and an engine room with space for cargo stacking. Immediate provision is being made on the first floor for pre-cooling facilities for 4,500 shipping tons with possible future extension for a further 4,500 tons. Access to the pre-cooling chambers is by rail up an inclined reinforced concrete ramp, and handling of fruit will be by battery truck to the shipping galleries, and then by wharf crane to the ships' holds.

The second floor, a portion of which will be used for fruit re-packing will be 800-ft. x 128-ft. The rest of the floor will be used for handling passenger traffic and incorporates the latest designs based on the terminal at Southampton. Catering and other amenities will be provided on this floor and access from the liners will be through a covered telescopic gangway.

When work is completed on the "T" jetty, ship repair facilities will be moved to the Bay Head where 77 acres of marsh ground has been reclaimed in preparation for the establishment of workshops and other amenities. A double-faced jetty 700-ft. long is now in the course of construction in the area and dredging work is well advanced with the deepening of the basin and approaches to the jetty.

Island View

The 1,065-ft. of timber-constructed wharves at berths 5 and 6, Island View, had become unsuitable for use by large vessels and in 1947 a start was made with the replacement of these by steel wharves. Difficulty was experienced in obtaining regular supplies of steel sheet piling at that time and the project was only completed in 1954 to give the port additional safe berthage.

The existing Island View channel, dredged to −36-ft. L.W.O.S.T., at present, provides access to the tanker wharves. However, with the ever increasing length and draft of tankers arriving at this port it has been decided to deepen the approaches to 42-ft. L.W.O.S.T., and to dredge a 1,400-ft. turning basin as an extension to the existing 1,000-ft. basin. The entrance to the channel has already been widened from 500-ft. to 700-ft. and the deepening is in progress.

A new tanker berth of 610-ft. in length at No. 7, Island View, was recently completed. This berth was constructed of two caissons built in the Graving Dock, floated out and sunk as two dolphins. A reinforced precast slab and beam platform was constructed on concrete piles between the dolphins to carry the pipe manifolds. Preliminary work has been started in preparing the landward approaches to the area where additional tanker berth, No. 8, will be constructed. This berth will have a depth of −42-ft. L.W.O.S.T. and a length of approximately 840-ft. and is to cater particularly for deep drafted crude oil tankers supplying the refineries. It is anticipated that the construction of the wharf will commence early in 1961.

Maydon Wharf

In 1946 Maydon Wharf had 9,000-ft. of wharfage, a portion of which consisted of timber construction with a depth of 25-ft. L.W.O.S.T. Due to the increased draft of modern shipping making use of Durban harbour, and the ageing of the structures, it was decided to replace some of the timber sections with steel sheet piling and to increase the depth to 32-ft. 6-in. A start on this project was made in 1952 and by 1959 berths Nos. 1 to 4 and 13 to 14 were completed. The length of wharf thus converted was 3,150-ft.

The construction of a concrete wharf at No. 11 Maydon Wharf, by linking up the timber constructed end of berth No. 10, two concrete dolphins at No. 11 and the concrete end of berth No. 12 was completed in 1959, which provided an extra 518-ft. of concrete wall wharfage with a depth alongside of 35-ft.

Revised British Standards for Cranes

Revised editions of two important British Standards for cranes have been issued by the British Standards Institution. They are: B.S.2573, 'Permissible stress in cranes: Part 1: Structures' and B.S.466, 'Electric overhead travelling cranes for general use in factories, workshops and warehouses.'

B.S.2573 has been revised as a result of experience gained since it was first published in 1955 and the new edition is intended to form the basis for the design of all types of cranes. The standard has been considerably expanded to include guidance on many aspects not dealt with in the 1955 edition, including fluctuations of stress, basic stresses in bending for lattice girders and trusses, effective lengths of struts, basic shear stresses in web plates and minimum thickness of web plates, and the proportioning of web stiffeners. Metric versions of the tables are included as an appendix.

B.S.466 has also been extensively revised and now classifies cranes according to their intended duty; it also requires the crane structure to be designed in accordance with B.S.2573. Two significant innovations are that, where a rail is adequately secured to a crane girder it may now be regarded as part of the girder for load carrying purposes, and that the maximum deflection permitted is now related to the combined weight of the safe working load and the grab.

Copies of these standards may be obtained from the British Standards Institution, Sales Branch, 2 Park Street, London, W.1, B.S.2573, price 12s. 6d. and B.S.466, price 10s.

Application of Transverse Circulation Methods to Problems of Erosion and Siltation

By R. I. BATALIN, M.I.C.E.

Well known common phenomena in the regime of river and stream courses are:

(1) Erosion of banks on concave sides.
(2) Formation of shoals on convex sides.
(3) Siltation of navigation channels, especially along inflexion reaches.
(4) Siltation at tributary outlets and of artificial intake channels.

There may be numerous variations in topography of bed formations and bed load movements in each of the enumerated classifications and each subcase will require an appropriate variant in a design of works meant to deal with the problem.

General engineering practice of dealing with these problems by means of embankment walls or dredging offer solutions far from ideal.

Embankment walls are usually expensive. Also, though they may accomplish a desired purpose at the selected point, their influence on the river regime might create new unfavourable conditions further downstream.

In cases of navigation and intake channels their construction by means of dredging would be a straightforward job from the point of view of organisation and economy, but the task of their maintenance against either siltation or erosion becomes rather complicated and tedious The dredging operations cannot be continuous to follow spasmodic or gradual silting up, and the channel will rarely be working to its design dimensions and capacity, the cost also is high.

Transverse Circulation Method

Effective solutions to these problems may be achieved with deflector installation action which is based on transverse circulations induced in the stream by the component deflector shields or pontoons. The latter induce the transverse circulations within certain limits. The action will be localised, its intensity gradually diminishing and eventually ceasing at some distance downstream, so that the river regime downstream will be the same as it was before. The local problem will therefore have been solved without affecting the river course further down.

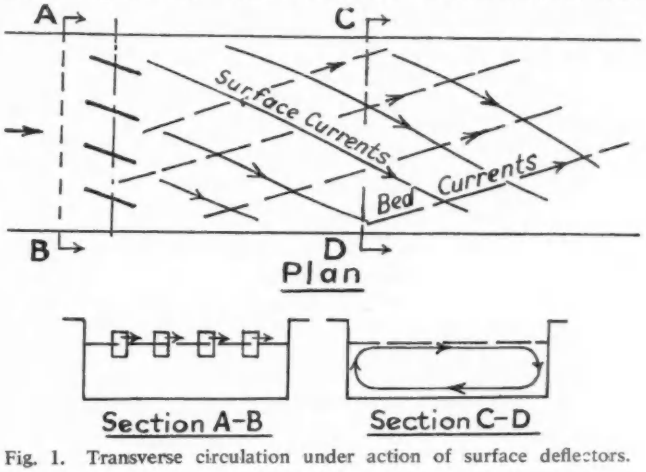


Fig. 1. Transverse circulation under action of surface deflectors.

The method of transverse circulation has been developed in the U.S.S.R. and numerous protection works of deflector type have been installed in rivers of European and Asian Russia. Their effectiveness has been checked in hydraulic laboratories and on the performance of existing installations. The author designed a series of deflector grids and systems for installations on the Ganges Kobadak Project, East Pakistan. Their capital cost and maintenance expenses are low and compare favourably with those involved in construction of embankments and/or dredging operations.

There are three basic variants in arrangement of deflectors which enable a transverse circulation of the desired pattern to be obtained.

Fig. 1 shows the action of the surface deflectors and Fig. 2 the action of the bed deflectors. When the latter are inclined in reverse position to that of the surface deflectors they induce circulation currents of the same direction.

Fig. 3 shows an arrangement of both surface and bed deflectors which would induce transverse currents of greater intensity and stability.

Fig. 4 shows an arrangement of deflectors at an intermediate depth which would induce two transverse currents in the stream. By their action two purposes may be simultaneously achieved, i.e. to reject the bed load and floating objects away from the right hand side.

For streams of moderate depth the deflector shields are constructed of timber planks or fascine fixed to uprights. For greater velocities it is desirable to have them of curved or streamlined shape. For heavier duties they are usually made of segment shape. They are slid over the posts and fixed at the designed height by means of bolts.

For deep streams and high velocities they are arranged into floating grids of one row and for still heavier duties into systems of double row pontoons. In the latter case, the pontoon shields and superstructure are fabricated of mild steel.

Anti-scouring Deflectors

Fig. 5 shows two types of floating deflector grids installed on the Gorai River in East Pakistan. The right bank there had been eroded on a concave bend opposite the stretch 21-22 miles of the Kushtia Main Canal within a quarter to half-a-mile from the latter. The water depth during floods varies between 8 to 25-ft. or more. Five grids along a bank length of over one mile were installed, two of the design shown on Fig 5a and three as per Fig. 5b. The grids of the first design have the shields fixed at right angles to the axis. This arrangement simplifies their manufacture. At the end of the bend the grids with obliquely fixed shields are more effective in action The grids are usually arranged at a sharp angle to the direction of flow. The working depth of the shields would be equal to 0·5H and 0·2H for small and big water depths (H) correspondingly. One component of the dynamic force of the flow would be acting along the axis towards the post driven into the bank; the grid is fitted with

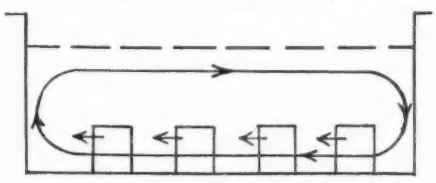


Fig. 2. Bed deflectors. Arranged at opposite inclination to that of surface deflectors; they induce transverse circulation of the same direction.

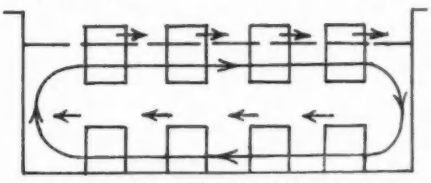


Fig. 3. Surface and bed deflectors induce transverse circulation of greater intensity and stability.

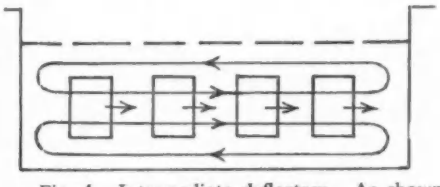


Fig. 4. Intermediate deflectors. As shown would reject bed load and floating object away from right side.

rollers at this end so that it can easily follow a rise or fall in the river level.

The deflectors of this arrangement induce a transverse circulation of which the part near the bed is moving towards the bank. The bed load is being brought against the bank and if the sediments are heavy enough they will stay there, thus building up the bank.

For shallower waters the shields would be of smaller dimensions and therefore could be of the fixed type. They would be suitable for protection of beaches or valuable land against erosion and undermining.

Anti-siltation Deflectors

Fig. 6 shows a general type of deflectors for installation at sites which need to be protected from the formation of shoals or from the extension of beaches on convex sides of streams. This type would induce transverse currents which would move the bed load away from the site. In case of intake channels

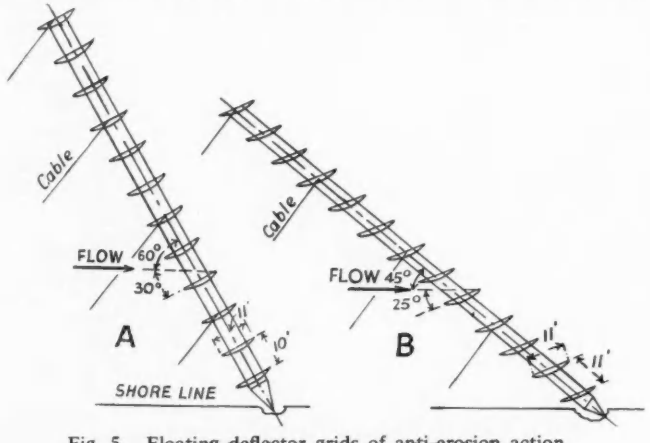


Fig. 5. Floating deflector grids of anti-erosion action.
(a) Deflector shields fixed at right angles to axis.
(b) Deflector shields fixed at oblique angle to axis.

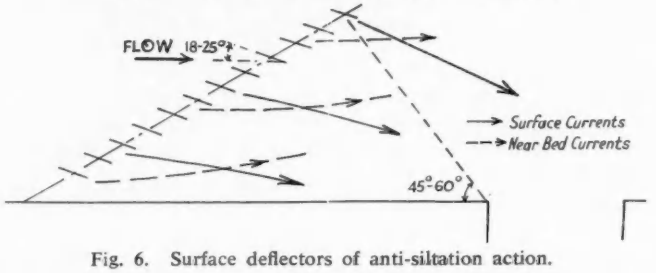


Fig. 6. Surface deflectors of anti-siltation action.

they would prevent the heavy bed sediments entering the channel while the surface jets would be directed into it on a broad and uniform width. There would be no entry eddies formed eating into upstream corners and depositing the silt at the downstream ones. The discharge capacity of the intake may be increased by as much as 30 to 50 p.c. over that obtainable under natural conditions. Any shoals that had formed earlier might disintegrate and be washed away.

For large installations the deflectors are assembled into floating systems of double row pontoons. Several of them are in operation on the Amu-Daria River at the head of main irrigation channels. The benefits obtained are extremely good. Prior to their introduction it had been necessary to maintain three feeders for the same intake, to carry on heavy dredging operations and to have the channel of unreliable discharge capacity. The installation of the deflector systems radically changed the conditions for the better. Now there is only one feeder, the discharge capacity of the channel has improved by 50 p.c. over design discharge, the canal is being naturally maintained in cleaner conditions and river banks in the vicinity are free of landslides.

On the basis of this experience a double row all-metal system of deflectors was designed for use on the Ganges River at the head of the Main Canal of the Ganges Kobadak Project in East Pakistan. The system is 506-ft. long and 32·5-ft. wide. The pontoon deflectors are of segment shape, 13·75-ft. long, 4·75-ft. wide and 7-ft. high, submergence being fixed at 6-ft. The pontoons are assembled into eleven sets of four units. The sets are joined into a flexible system by means of articulated joints. Axially the system is anchored to a concrete block and each set has a cable tying it to a trolley run along an operating platform. The intake capacity of the Main Canal is equal to 3,500 cusecs. It is estimated that the capital cost and maintenance charges for the system would amount to about £10,000 per annum as against £17,000, cost of maintenance works by dredging.

Varied Applications of Deflectors

Above are described the main types of deflectors and their installation. There may be many variations in their practical application. The deflector grids as shown on Figs. 4 and 6 combined will make one of an intermediate type and would be suitable at a site where variations in water levels are on wide range and where it is desired to have works protected against the bed load and floating debris.

For training a river course several grids of various design and distribution along the course would realise the hoped for results efficiently and on a more or less permanent basis.

One would like to pose a proposition for the use of the deflectors in sea defence works instead of plain and continuous groynes.

On the Volga River at Stalingrad a system of deflectors protects a water supply intake conduit sited in the middle of the river.

A barge fitted with four deflector grids may be used for maintenance dredging of a navigation channel. Some have been tried in Russia and the Central Hydraulic Laboratory in Paris has designed one for use on the Niger River.

In India the application of the deflectors for various purposes is finding a wide interest.

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Reversing Flow of Two Russian Rivers

It is expected that work will soon start in the U.S.S.R. on an ambitious plan to reverse the flow of the rivers Pechora and Vychegda which at present flow into the Arctic Ocean. The project entails damming both rivers so that the water will be diverted through canals into the River Volga, thus bringing considerable resources for the great irrigation scheme designed to make the Russian agricultural lands independent of the weather.

The Volga, which now resembles a chain of lakes separated by hydro-electric power dams, has not enough water in itself to irrigate the adjacent steppes during times of drought. Water diverted from the northern rivers would also help to solve the problem of pollution from the many factories along the banks of the Volga, and would begin to refill the Caspian Sea, the level of which has fallen in the last 30 years by more than 6-ft., with great damage to its fish resources and off-shore oil installations. According to calculations, if work begins on the project this year, enough water will be flowing through the Volga by 1970 to prevent any further fall in the level of the sea.

Improved Passenger and Cargo Facilities at Southampton

New Passenger Terminal

Situated at berths 105/106 at the New Docks, Southampton, the new passenger terminal recently completed for the P. & O.-Orient Line by the British Transport Commission follows the same high standard of elegance and comfort provided at the Ocean Terminal, 102 berth and other of Southampton's post-war accommodation.

The new building is placed midway between the existing passenger-cargo sheds at berths 105-6, replacing a smaller passenger hall built when the New Docks were opened. It has a frontage of 196-ft. and a depth of 102-ft. and the accommodation comprises a large central reception hall on the ground floor, shipping and Customs' offices at mezzanine level and a balcony and covered enclosure at top level for visitors meeting or seeing passengers away.

The shed has a structural steel frame, concrete encased. The main stanchions, thirty-two in number and ranging in size from 16-in. x 8-in. to 10-in. x 6-in. rolled steel joists, are supported on thirty-six West's type circular shell reinforced concrete piles of 17½-in. and 20-in. diameter.

On the first floor, the north mezzanine office accommodation is slung from steel cantilevers at roof level attached to the structural stanchions and project 6-ft. 9-in. northwards and 8-ft. 3-in. southwards. The rail platform canopy is cantilevered northwards 7-ft. 4-in. from the outer floor beam. The front portion of the first floor is slung from cantilever steel beams at second floor level, projecting 7-ft. 4-in. from the front line of stanchions to form the south mezzanine office accommodation. The rear portion is supported on beams spanning the front row of stanchions and on a lattice girder and beams spanning the rear row of stanchions.

The Visitors' Enclosure is over these south mezzanine offices on the second floor. The Exterior (balcony) portion is cantilevered 9-ft. 6-in. southwards from beams spanning the outer ends of the main steel cantilever beams. The Interior portion is supported on the latter beams and on beams spanning the outer row of stanchions and on the lattice girder or beams spanning the rear row of columns.

The end walls of the building are of brickwork and the interior walls of brickwork and blockwork. The concrete floors are heated throughout by cables embedded in concrete screed.

The main roof and ceiling is supported on tubular steel rafters at 9-ft. centres slung from 4 No. main (lattice) girders 91-ft. 2½-in. span, spaced 48-ft. apart. These girders, top and bottom chords, box section and tubular web members are of all welded construction. The visitors' enclosure roof is also of all welded tubular steel construction, comprising 10 No. barrel-vault shells in 12-ft. bays with a transverse length of 26-ft. 9-in. and having a radius of 10-ft. There is a Ruberoid insulated steel roof decking system with three layers of felt covering throughout.

External Treatments

This section refers to the north and south elevations only.

The ground floor is faced with slate green reconstructed stone slabs pointed in white, above which is 7¾-in square Flemish type glass blockwork pointed in yellow ochre with clear opening lights inset. The main entrance doorway is faced with ¾-in. thick "Derbydene" marble slabs and there is terrazzo to steps and vestibule floor. The immigration halls in the sheds are faced with Portland stone with a coloured Tyrolean finish, and the intermediate bays of the first floor comprise a window walling system with infilling panels faced with decorated asbestos sheets; the ends bays having vertical cedar boarding with 4 No. picture windows inset. The visitors' enclosure has the same walling system and there is cream coloured asbestos cement double sheeting and barge board above the north mezzanine offices.

The interior walls of the waiting hall are panelled in Siamese teak with portions of solid teak free form shaped slatted panelling on the east and west walls. The main ceiling is suspended with white flat face finish incorporating square lighting diffusers set out in regular pattern. The buffet is faced with rosewood veneers with sliding folding perspex and metal screens. The island stand, incorporating bookstall and news stand, Bureaux de Change and enquiry and rail booking stand, is also faced in teak. A striking abstract mural is painted on the walls of the waiting hall nearest the quayside. There is a public address system with the loudspeaker cabinet sited over the island stand.

Both the P. and O. and Orient Lines have long and notable associations with Southampton and, indeed, it was two ships of the P. & O. which opened the first dock ever to be built at Southampton, the Outer Dock in 1842. The Orient Line commenced its association with the port in 1926. Now the P. & O.-Orient Line link with Southampton will be further strengthened by the decision to base the new Oriana and Canberra at the port. Both the port and the ships will play their parts in fostering travel and trade between Britain and Australasia.

Quayside Façade of the new Passenger Terminal.

New Cargo Transit Shed

Southampton's freight-handling facilities have also been augmented by the addition of a spacious single-storey cargo shed at berths 26-27 Empress Dock. The new accommodation, which occupies nearly the whole length of the northern face of the dock, was used for the first time when the cargo ship "Bukken" called early in March to discharge fruit from the Mediterranean, a traffic for which the shed is ideally suited.

The new building, which replaces two separate sheds formerly on this site, measures 725-ft. long with a depth of 95-ft. It is of steel portal frame construction, with panelled brickwork, supported on concrete shell piles. The absence of intermediate stanchions gives a completely clear working space for the whole of the floor area.

Access to and from the quay is by twelve large doorways, measuring 18-ft. high and 23-ft. wide, each having a pair of sliding doors. On the landward side twenty-six galvanised steel roller shutter doors give access to the combined rail and road loading platform. The latter is outside the shed as opposed to the usual type of inside gullet platform, and extends the whole length of the building. The platform can be used by rail or road transport as the rail track is flush with the road surface. Protection from the

Interior view of the new Cargo Transit Shed.

The new Cargo Transit Shed. A night view of the rail-road loading platform showing the good illumination given by the reflector fluorescent tubes.

weather is given by an overhead canopy.

There are four railway tracks serving the quay and shed: two on the quayside, one immediately inside the shed and one serving the loading platform. Access to the shed at each end is by two large steel roller shutter doors.

Bonded Customs cages are provided at the east end of the shed and chalet type offices serve the needs of the clerks and foremen.

The Berth is served by five electric level-luffing cranes, all of 65-ft. radius.

A feature of the new building is the electric fluorescent lighting, both for the interior and exterior, which gives a much higher level of illumination than the older type of lighting. Inside the shed lighting is provided by 150 standard 8-ft. industrial fluorescent fittings which follow the framework of the roof, five tubes to each bay. Lighting on the quayside is provided by 5-ft. reflector fluorescent tubes mounted in fibreglass fittings at 24-ft. centres recessed into the underside of the coping along the south wall, whilst on the rail-road loading platform similar tubes are mounted on the face of the wall. This is the first time that fluorescent lighting has been used to illuminate a cargo shed in the docks, and the whole lighting scheme was designed by the electrical department of the Chief Docks Engineer at Southampton. Good natural lighting within the shed is given by fibreglass glazing in the roof.

The work for both these new facilities was executed under the supervision of Mr. J. H. Jellett, O.B.E., M.I.C.E., Chief Docks Engineer.

Liverpool Observatory and Tidal Institute

Abstracts from Annual Report for 1960

The annual report for 1960 was presented by Dr. J. A. Rossiter who has been acting as Director of the Institute since the retirement in September last of Dr. A. T. Doodson. This report marks the end of an era in which the Mersey Docks and Harbour Board shared with the University of Liverpool the responsibility of governing the Institute. In future, the University will be in sole charge of the growing interests of the Institute.

MEAN SEA LEVEL IN THE BRITISH ISLES

Since its formation in 1958 the Mean Sea Level Sub-Committee of the Advisory Committee for Oceanographic and Meteorological Research has achieved a remarkable transformation in the status of mean sea level observations and studies in this country. The collaboration between the Ministry of Transport, the Ordnance Survey, the Hydrographic Department of the Admiralty, the National Institute of Oceanography and local harbour authorities has resulted in a network of modern tide gauge stations being set up around the coasts of the British Isles. Every effort is being made to ensure the accuracy and value of the installations, and in all this work the Institute through its representative on the Sub-Committee has played its full share.

When the programme is completed within a few years it is expected that there will be in continuous operation some 40 stations. The mean sea level analysis of most of the records thus obtained has been made the responsibility of the Institute, and a list of the reductions completed during 1960 will be found in the Report. Provision has also been made for the reduction to monthly and annual means of old series of tidal records, and it is anticipated that the results will be of considerable interest in the study of sea level variations around the coasts of the British Isles.

STORM SURGE RESEARCH

(a) **Interaction between Storm Surge and Tide**

An idealised mathematical model of the Thames has been used to investigate the observed phenomenon of interaction between surge and tide. This effect takes the form of an accentuation of both positive and negative surges on the rising tide. Assistance was provided by the staff of the Computer Laboratory of the University of Liverpool in the programming of the Laboratory's DEUCE computer to calculate the response of the model to different combinations of tide and surge. The results obtained so far show that irrespective of the timing of the surge relative to the time at the mouth of the estuary, by the time the surge has penetrated to the position in the model equivalent to Southend, the observed phenomena have been reproduced to a remarkable degree.

The most plausible physical explanation of the interaction is that the presence of a surge in the estuary, in affecting the mean depth, also modifies the rate of propagation of the tide and the amount of bottom friction the tide experiences. As both these effects act in the same direction, it is possible to say that a positive surge accelerates the tide, and in consequence there is a positive contribution to the surge, from the time-displacement of the tide, which is a maximum on the rising tide. A converse argument holds for a negative surge. Whilst this explanation might have been expected on qualitative grounds, the indications

of the model give quantitative estimates of these transient phenomena, and have been welcomed by the Flood Warning Organisation as being of considerable practical value. Further work along these lines, with particular reference to maximum levels and their propagation, has been recommended by the Ministry of Agriculture, Fisheries and Food, the Ministry promoting the Institute's surge research programme.

(b) **Frequency of Occurrence of Abnormal Tidal Levels**

The investigation of the frequency of occurrence of abnormal tidal levels has continued to receive attention and in particular the practice of fitting a linear logarithmic function to the frequencies of a selected range of observed high levels received support from a theoretical investigation carried out by Dr. Doodson. This study considered the effect upon the character of the distribution by surges of different shapes. Cases considered were:—a surge similar to the positive part of a diurnal tide, a bell-shaped surge extending over 24 hours and a bell-shaped surge extending over 8 hours. The close relationship between the results from the different cases, at least in the higher levels, was notable and the indication given was that the influence of the tide is most marked for small surges but that after a surge exceeds about one-fifth the amplitude of tide, the effect becomes small.

The practical study of abnormal tidal levels for twelve west coast ports has now been brought to a satisfactory conclusion and Mr. Lennon has prepared a paper upon this subject which has been accepted for publication by the Institution of Civil Engineers. Considerable difficulty was experienced here in that the characteristics of the frequency distributions obtained for the west coast prohibit the general application of the established statistical methods for the treatment of extreme values. Mr. Lennon employed no less than six different techniques including methods due to Gumbel, Barricelli and Jenkinson in addition to the normal frequency distribution, adjusted for observed skewness and degree of flatness, before he could make a satisfactory estimate of the maximum levels most likely to be attained once in one hundred and once in two hundred years.

The results were consistent, one with another, for the different ports in a geographical sense so that it was possible to make certain regional inferences for the one hundred year maximum level, expressed as a probable exceedance over mean high water springs by an amount measured in terms of the spring range of tide at the port.

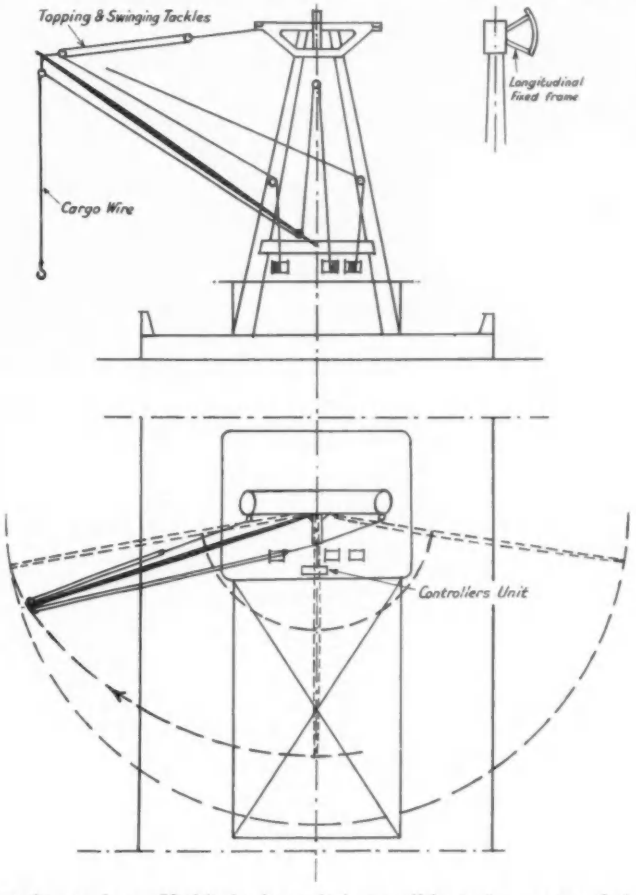
This work has been appreciated by engineers concerned with land drainage and coastal defences and is already being put to practical use. Having defined in this way the extent of the danger to be expected from storm surge effects along our western shores, the question of further attempts to establish a flood warning system, in what is generally agreed to be a most intractable region in this respect, depends upon an assessment of the need after local authorities have balanced the existing and proposed coastal defence works against the computed danger levels.

Hallen Swinging Derrick

Since 1957, the development of containers and of unit loads of heavy weights has called for the equipment of ships with handling gear of increased capacity. With conventional ships' derricks, it is necessary to change the rigging for heavy work, an operation which is often long, expensive and, if not done with expert care, hazardous.

This item of equipment is manufactured by MacGregor-Comarain S.A. of Paris, France, who state that it was produced in an endeavour to find a device with all the advantages of cranes, but also enjoying the simplicity of the conventional derrick. This device, the manufacturers believed, had to (1) enjoy a working radius of 180°, with the possibility of lifting or lowering a load at any point without any modification of rigging; (2) be able to work however great the list of the ship; (3) keep the deck clear of guys or other obstructions; (4) be capable of being operated by one man; (5) occupy as little deck space as possible and (6) be operated by any standard winches.

"The Hallen swinging derrick was designed to satisfy these requirements," state the manufacturers. "If one of the three winches is damaged, the derrick can be used as a conventional one. This improved swinging derrick can be fitted to any ship



now in service. If this is done, it is possible to keep one of the two existing derricks, the mast, the upper and lower tables and the two winches, so that the extra equipment is only a winch and a longitudinal fixed frame."

As will be seen from the diagrams, the derrick is supported by two topping lifts and swinging guys, and tackles lead from the head of the derrick to fixed points at the ends of a wide cross-tree. "When one of these tackles is slackened off," it is stated, "the derrick swings outboard to an extreme position at right angles to the vessel's centre line. In this position, the derrick is stable, since (because of the longitudinal outrigger), the angle between the two tackles is sufficiently large."

Traffic at Major U.S. Ports in 1960

The Maritime Association of the Port of New York has stated that the total number of ocean-going vessels calling at the 11 major ports of the United States during 1960 amounted to 114,738, an increase of 191 ships over the previous year. New York accounted for the largest share of this traffic, handling 23.5 per cent which represented a decrease of 0.2 per cent compared with the 1959 figures. The Port of Philadelphia maintained its position as the second busiest port with a recorded 12 per cent of all vessel traffic, while Hampton Roads had a total of 9.9 per cent.

The National Harbours Board of Canada

Review of Administration and Present Facilities

It is a normal occurrence for the Chairman or other representatives of the National Harbours Board to visit its customers to discuss with them problems of mutual interest, and this month Brigadier Maurice Archer the present chairman is visiting various ports in the United Kingdom and Europe. During his brief stay in London, he gave a speech introducing the Board and outlining its facilities and, as many of his remarks are likely to be of interest to our readers, extensive abstracts are given below.

There is no need to stress the importance of harbours to the transportation system of a nation. Their significance is in direct ratio to the volume of the nation's international and domestic waterborne traffic and, in a country where foreign trade is a prime consideration, the value of its harbours is correspondingly high.

This is particularly true in Canada, where vast distances and dependence upon foreign trade make it essential that harbours be effective links between deep-sea and inland transportation systems. These links are intimately related to foreign trade and, thus to the whole economy of the country.

The National Harbours Board was formed by the Canadian Government in 1936 after a survey of Canadian ports by Sir Alexander Gibb of London, England. The object of the government in creating this Board was to ensure greater efficiency and economy in operations, improvement and strengthening of engineering services, uniformity in regulations and tariffs and stabilization and continuity of administrative personnel at Canada's deep-sea ports.

Ports under Board administration are Halifax and Saint John, N.B. on the Atlantic Coast, Chicoutimi on the Saguenay River, Quebec, Three Rivers and Montreal on the St. Lawrence River, Churchill on Hudson Bay and Vancouver on the Pacific Coast. The Board also administers transfer grain elevators at Prescott on the upper St. Lawrence and Port Colborne on Lake Erie.

These deep-sea harbours are strategically located to connect the international sea routes with inland transportation lines and also serve important coastal and intercoastal trade. They handle today about 75% of Canada's overseas foreign trade. Significant gains were registered during 1960 in the total traffic at these ports, reaching a record figure of 52 million tons, a 7% increase over the 1959 figures.

The National Harbours Board is a federal crown agency maintaining a small headquarters staff in Ottawa with secretarial, legal, traffic and engineering branches. Local administration of the ports is in the hands of port managers.

The general policy of the Board is to provide the necessary major facilities for public use, but to refrain from performing services that can be provided adequately by private interests. At the eastern harbours and Churchill, it provides the wharves and transit sheds for the handling of waterborne traffic, but the handling services such as rail car and truck loading and unloading and stevedoring at these facilities are performed generally by the carriers and stevedoring companies. At Vancouver, the Board both provides and operates the wharves and transit sheds, but all regular wharf services are performed by private stevedoring companies.

Many aspects of port business are intangible and the quality of service can never be precisely measured. It is obvious that in exporting and importing goods the main interest lies in the safe, rapid and economical transportation of the cargo from its point of origin to its final destination and this depends on the efficiency of port operations.

How do Canada's national harbours rate on these qualities? Their port facilities and services equal any on the American Continent; ships are assured a quick turn round, and easy access to and egress from the port, is provided by an efficient network of railways and highways, by inland waterways and, from most ports, by fast air express service. As far as costs are concerned, steamship rates are the same to all North Atlantic ports but, in addition, rail freight rates from or to Canadian ports are generally identical with those for United States ports. In other words, it costs no more to reach an interior Canadian port from a Canadian harbour than it does from one in the United States, and it may actually cost less.

When the winter closes some of Canada's national harbours, others under the same administration and with identical charges are ready to receive the goods. It is usual for shipping companies to transfer their operations in winter from those ports on the St. Lawrence that are closed to Halifax and Saint John. This permits efficient use of office staff while maintaining continued year-round service to their clients.

Like any other business, the levying of harbour charges must be undertaken with care and consideration to the many factors involved. The ports must be kept competitive with other harbours and, at the same time, attention must be given to the cost of providing, operating and maintaining the facilities and services.

Major charges at the Board's eastern harbours and Churchill are embodied in tariffs of top wharfage, dockage and harbour dues. While the rates at seven ports have thus been standardized under these tariffs, this does not imply a system of rigidity as, in special cases and where circumstances warrant, the Board will agree to an adjustment in charge. At Vancouver, separate tariffs are in force which, while based on the same principles as eastern port charges, have been modified to meet special conditions on the West Coast.

The Board, like other business concerns, has been confronted with the problem of ever rising costs. Nevertheless, the harbour charges have been increased very moderately over the past twenty-five years when compared with commodity prices, freight rates and other charges. Careful management and rising traffic volumes have combined to keep harbour charges down. The major source of revenue, the Tariff of Top Wharfage Charges, has only been increased by 25% since 1938. At Vancouver, the Tariff of Cargo Rates, one of the port's major tariffs, was actually **reduced** by 40% in 1953. Minor increases for services such as refrigerated storage, electricity charges, water rates, etc. have been effected from time to time to bring them more into line with costs and competitive rates.

Improvements to the Ports

In the last five years, Board expenditures on the modernizing and extension of its port installations were in excess of £50 million. A rapid description of some of the major work under taken in this five year construction programme includes a new pier and new transit sheds at Halifax; grain elevator improvements, a new transit shed and shed extensions at Saint John; a grain elevator annex with marine towers and unloading equipment, a new oil berth and transit shed at Quebec; a wharf extension and transit sheds at Three Rivers and the enlargement of the grain elevator at Churchill. A transit shed was built at Prescott last year and an oil berth has been installed at Chicoutimi.

At Montreal, wharf construction furnished an additional 11,000 linear feet, or approximately two miles, of new wharf space including 19 new berths and the erection of new transit sheds added nearly 23% to the aggregate shed floor area of the harbour. Improvements to the grain elevator system included the construction of a 1.6 million-bushel capacity annex, marine towers and special unloading and clean-up equipment.

All new wharf construction is designed to furnish maximum space on the wharf apron with paved areas providing functional

access for the inland services of rail and road transport.

At Vancouver, construction of the new Centennial Pier has provided the harbour with one of the largest piers on the North American Continent. In addition to this facility, overall improvements were made to the grain elevator system including a one million bushel storage addition to one of the elevators.

Estimated expenditures for capital works in 1961 are £10 million. The programme includes new docks at Saint John, Quebec, Montreal and Churchill; the reconditioning of an existing dock at Halifax; new transit sheds at Three Rivers, Quebec and Montreal (one recently constructed transit shed at Montreal measures 1,500-ft. by 150-ft. and is believed to be the largest in the world); the installation of four quay cranes on the recently opened Centennial Pier at Vancouver, deepening of a grain loading jetty to provide accommodation for deep draft vessels; and new open areas in conjunction with wharves at Halifax, Saint John and Montreal.

A new grain elevator being constructed at Montreal is expected to become operational in 1962. This addition will increase the aggregate storage capacity of harbour elevators to 22 million bushels and the port will have the potential to ship over 300 million bushels of grain a year.

The latest book value of assets administered by the Board represents an outlay of £150 million. Overall facilities include wharves providing 27 miles of berthing space capable of accommodating 290 modern cargo or passenger vessels at one time; 99 transit sheds with floor space aggregating over six and a half million square feet; 14 grain elevators with a total storage capacity of 51 million bushels; 3 cold storage warehouses with a combined storage volume of 5 million cubic feet; 2 terminal railway systems with a total trackage in excess of 85 miles; shore and floating equipment, workshops, etc. In addition to its technical installations, the Board provides and has available large areas for industrial sites.

One recent example of Board development opening the way for private industry is the land reclamation project underway at Quebec harbour. The British Petroleum Company of Canada Ltd. has pioneered the development of installations in the area and recently commenced operations with storage tanks and an administration building. To encourage further industrial concerns, a wharf is being constructed with Board capital and suitable road and rail connections will be provided.

Private industry operates terminals at Halifax for handling bulk coal, bulk gypsum and oil; special installations for petroleum traffic and the sugar trade are run by private concerns at Saint John and, at Vancouver, private capital has developed and operates terminals for the handling of bulk cargo. At Montreal, special equipment for coal and sugar traffic is in the hands of private industry.

With the exception of Montreal, shedded and open berths at Board harbours are assigned to each ship on entry or, in other words, on a ship-to-ship basis. At Montreal, most of the transit sheds and certain open wharf areas are leased each year for the navigation season. Transit sheds are leased to shipping companies that operate extensive and regular services to and from the port. Open wharf areas are leased to shipping companies or other parties who will guarantee their extensive use for waterborne traffic. Each lessee at Montreal is given prior berthing rights to the berth adjoining his leasehold, but the Board reserves the right, when the berth is not required by the lessee, to permit its use by other vessels to berth and handle traffic that does not involve the use of the leasehold.

At all harbours there is a limited period of free time during which cargo unloaded from ships may remain in the sheds or on the wharves. Sufficient free time is also allowed in which to assemble cargo for prompt loading to ships that are due for immediate berthing.

The existence of good pilotage and the necessary tug services enables ships to proceed from open water into the national harbours and to their assigned berths without delay. Efficient aids to navigation are provided in the form of lights, buoys and reporting stations for direct communication of vessel movements, weather and other shipping intelligence.

Litigation in the Port Industry

Slippery Ground and Reasonable Care

By LAURENCE WEBLEY, LL.B.

In the not unusual event of a dock or quay surface becoming slippery it behoves the dock authority to take reasonable care. This is mainly a question of degree and this together with the principles involved was recently illustrated by the case of Berry v. the Port of London Authority.

The plaintiff, Berry, had slipped on some cornflower. He had come to the Authority's premises in his capacity of driver of a van owned by J. Sullivan and Co., his employers, for the purpose of delivering confectionery to "L" shed at the South West India Dock. There was a road and railway between this shed and the quay and the accident happened at one of the shed entrances opening on to this road. A few days before a consignment of cornflower had passed through this entrance and some of it had spilled on the ground. After this had happened rain fell on top of it and the surface became exceedingly slippery.

On the day in question Berry had driven his van up to the dock entrance. A British Road Services lorry was already outside off-loading goods. Berry waited sitting in his cab and when, eventually, it moved off he drew up to the doorway and stopped with his van facing Eastward and the tail approximately level with the East side of the entrance, thus allowing the full length of it for unloading. In assessing the extent of the care that the Authority had, in fact, exercised to make the slippery surface safe the position of the van assumed some importance.

Berry got out of his cab and walked towards the back of his van which was a covered one with a roller shutter at the rear. He had half turned to speak to the man in charge of the unloading gang when his feet flew from under him and he fell heavily and dislocated his right shoulder.

In the subsequent action Berry claimed that the Authority had been negligent. He declared that the roadway at the shed entrance was in such a condition because of the wet cornflour that it constituted an unusual danger or trap. The Authority knew, or should have known this. They had neglected either to warn him or remove the cornflour and make the road safe. He also alleged a breach of Regulation 1 of the Docks Regulations 1934 but this was not proceeded with.

The Authority denied all this and declared that Berry had not looked where he was going.

Reviewing the evidence his Lordship said that the ground in question had been swept with a broom. It had also been sanded over the width of the entrance and about a lorry's width from the shed. Clearly the area had been found to be slippery. One of the Authority's own witnesses had said it was like a skating rink, anyone could have slipped without sand. Another had said that he had seen Berry on the ground three feet from where the sand had been put. His Lordship remarked that he had derived the possibly mistaken impression that none of these witnesses were very unwilling to hear compensation ordered for the plaintiff. However, that might be it was established that the quay in the

neighbourhood of the shed entrance had been made slippery by an overnight fall of rain on the cornflour but that sand had been put down before Berry fell.

Three questions arose: how did the plaintiff fall? Was he on the sanded area? Was the sanding adequate and reasonable? His Lordship concluded that the plaintiff had fallen at the rear of his van and at the edge of the sanded area. In his Lordship's view the sanding was inadequate. He did not think the use of a hose was called for. But the sand did not extend far enough, nor was there enough of it at the edge of the area. The surface was dangerously slippery. Two previous cases bore on this matter, Tomlinson v. Railway Executive and Blackman v. Railway Executive, both in 1953. In the first the plaintiff fell in getting out of a train on to a platform made slippery by snow that had only fallen 15 minutes before. The Court of Appeal had rejected the plaintiff's claim. They had said the Railway Executive had a duty to take reasonable care. In relation to a sudden fall of snow this meant that it should be cleared away as soon as reasonably practicable. It did not mean taking measures regardless of expense to ensure that at all times they had such resources of staff available as to clear away unexpected falls immediately.

In Blackman's case the patch of oil in the station on which the plaintiff slipped raised the question whether there was a failure to use reasonable care to keep that part of Paddington Station reasonably safe for passengers. Blackman was unable to satisfy the court there had been such a failure.

But, his Lordship declared, in the circumstances of this case Berry had established what Blackman and Tomlinson had not, namely that the defendant Authority had not taken reasonable care. Berry had not a full knowledge and appreciation of the risk, he had not failed to exercise reasonable care for his own safety and he had not contributed to the accident in any way by being negligent himself. His Lordship accordingly awarded Berry £365 for his dislocated shoulder.

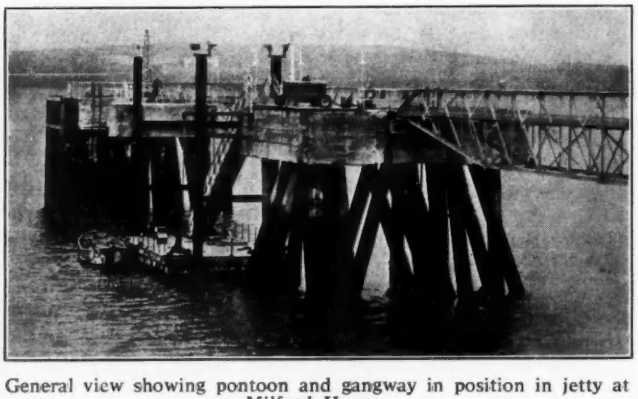
Manufacturers' Announcements

Aluminium Pontoon for Milford Haven

An interesting marine structure recently completed is an aluminium small craft pontoon built by Whittingham and Mitchel Limited, Chertsey, Surrey, for the Esso Petroleum Company's marine terminal at Milford Haven. A similar pontoon has also been supplied for the Fawley terminal. The main structure in each case has been of aluminium, primarily to reduce the labour and expense of frequent maintenance.

Of overall dimensions 50-ft. x 22-ft. x 5-ft. 3-in. in depth, the pontoon was fabricated in four sections and assembled on the site before lifting into place. The internal framework of part riveted and part welded construction, consists generally of 3-in. x 3-in. x 5/16-in. ordinary angles, with buoyancy provided by 24 cylindrical tanks 3-ft. 3-in. in diameter and 5-ft. in length welded from 10 s.w.g. aluminium sheet, each suspended from yokes by aluminium straps in such a way that the upthrust of the buoyancy provides an additional retaining force. Each tank has a trunked manhole for access if necessary, and has two transverse internal diaphragms. All the aluminium used has been supplied by Alcan Industries Ltd.

Stainless steel bolts are used to assemble the three separate sections of the pontoon, and the hardwood sheathing that covers



General view showing pontoon and gangway in position in jetty at Milford Haven.

the deck and sides is bedded in bitumen where it comes into contact with the aluminium structure. In addition to the hardwood sheathing, a heavy elm fender is fitted along each side.

The total weight of the pontoon, which floats at a light draught of 1-ft. 9-in., is about 17 tons, and the weight of the aluminium structure about 5 tons. The reserve buoyancy is about 20 tons.

In its operating position the pontoon is held between two pairs of vertical steel guides by patent spring-loaded shock-absorbing rollers, designed by Whittingham and Mitchel which both allow free vertical tidal movement and prevent any associated transverse movement. For access from the jetty to the pontoon a 50-ft. aluminium alloy gangway with self-levelling steps is fitted.

Independent High-Speed Derricking Unit

Thomas Smith & Sons (Rodley) Ltd., announce that a new independent high-speed derrick unit and a swing brake are now available for the Smith '12' excavators and crawler cranes. These two units will enable the crawler-mounted machine to hoist, slew and derrick simultaneously, and, if used in conjunction with the special planetary-load-lowering drum unit which is also available, will complete the equipment for transforming the '12' into a sensitive precision crane. All this equipment is now available in the form of optional extras on new machines.

The derrick unit comprises a totally-enclosed worm-driven drum unit which is powered from the first machinery shaft by spur gearing through a pair of friction clutches, all encased and using the basic machinery oil flow for lubrication. Also incorporated in the design is an automatic brake which is fitted with an interlock device to prevent the clutches being applied should the brake become out of adjustment. The control for the independent derrick unit is of the dead-man's-handle type, the whole system returning to safety in the event of the operating hand lever being released.

The hand-operated swing brake is fitted to the first-machinery-shaft clutch disc, which controls the drive to the slewing motion. This brake is of twin-shoe construction, operated by overcentre control, is very light in operation but is sufficiently powerful to hold the machine on any slope.

Plastic Float for Underwater Drilling

A simple float for underwater drilling that eliminates the use of rafts has been developed by Ripley and Associates, Soil Consultants of Vancouver. Fabricated from Styrofoam, a foamed polystyrene produced by Dow Chemical of Canada, Limited, the float is small enough to be loaded on to a lorry and light enough to carry when there is no access by road to the drilling site.

Previously, when drilling river and lake beds for soil samples, it was necessary to rely on floating craft hired from local fishermen or loggers to carry drilling equipment. The foamed polystyrene float provides a stable yet easily mobile platform for drilling operations and has been used successfully for the past year for a variety of jobs.

River Patrol and Pilot Launches for Iraq

John I. Thornycroft & Co. Ltd. have recently completed a valuable contract from the Middle East amounting to some £80,000. The order was placed by the Iraqi Ports Administration and comprised a dozen craft of which eight were river patrol launches and four pilot despatch launches.

To obviate as far as possible any delays it was decided to divide construction between the Thornycroft yards at Hampton-on-Thames and Singapore: in the latter case the propelling machinery and the bulk of the equipment and fittings being supplied from United Kingdom sources.

The river patrol launches are 36-ft. in length, with beam of 9-ft. and draught of about 3-ft. They are intended for service on the lower reaches of the Shat-Al-Arab river. Teak on chengal timbers is used for the hull planking and each boat is installed with a Thornycroft diesel engine of 125 b.h.p. with which a speed of 13 knots is attained.

In the accommodation the forepeak is arranged as a chain locker to which there is access by a portable panel. Adjoining is the wheelhouse in which the steering wheel, engine controls and instrument panel are adjacent to the helmsman. Aft of the wheelhouse and reached by a sliding door, is the engine room and next to this the saloon. In the cockpit aft, protected by a portable canvas awning, there are batten seats on each side.

The pilot despatch launches are of similar stout construction to the river patrol boats and will operate at the offshore oil terminal of the Basrah Petroleum Company at Basrah. Initially they will provide the link between the parent pilot cutter and tankers, and eventually between the offshore terminal and the tankers.

These boats are 21-ft. in length with a beam of 7-ft. and draught of 2-ft. 3-in. The hulls, also of teak, have built-in plastic foam buoyancy.

The forepeak serves as a warp locker and over the adjoining forward cockpit is a waterproof ply canvas-covered shelter. An open deck over the engine space with a hand rail facilitates boarding. The helmsman's position is aft with tiller, engine control, reverse lever and instrument panel close at hand.

A Thornycroft 40 b.h.p. diesel engine with direct drive provides a speed of 7½ knots, and engine cooling is by means of an external heat exchanger.

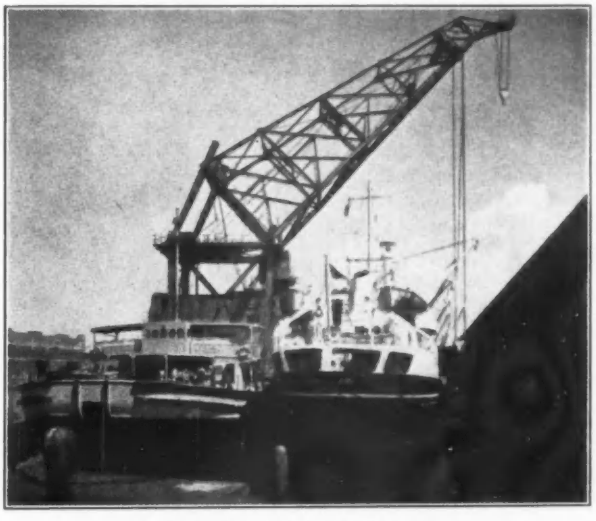
Floating Crane for Liverpool Docks

The twin-screw floating crane Samson commissioned earlier this year by the Mersey Docks and Harbour Board has been developed to meet the difficult conditions prevailing at Liverpool Docks. These include the need for high manœuvrability due to the confined areas in which it has to operate, and for a higher speed than normal, 10½ knots, to cope with the fast tidal currents prevailing in the main channel.

Samson has an overall length of 183-ft. and a moulded breadth of 56-ft. To offset the very high windage areas of the main structure the vessel is fitted with a specially shaped hull. Accommodation for the officers and crew is below deck, thus leaving the deck itself free for the storage of cargo. Fully ventilated modern cabins are provided for the operating personnel.

The main hoist of the crane has a capacity of 60 tons up to a maximum radius of 78-ft. 8-in. while that of the auxiliary hoist is 25 tons up to a maximum radius of 93-ft. 8-in. Operating speeds of the hoists are 15-ft./min. and 55-ft./min. respectively. A power-driven travelling ballast weight counterbalances the loads being lifted. Slewing through 360 degrees can be carried out in four minutes with a 60-ton load on the hook.

To assist in manœuvring the vessel in the confined waters of docks and alongside ships, a propelling device is fitted to the bows. Known as a bow-steering pump, it consists of an axial-flow type pump sited in a duct having outlets on the port and starboard sides of the craft. The pump, which is driven by a 200 h.p. electric motor can expel water from either outlet, exerting a maximum thrust of approximately 2 tons. Additional manœuvrability is obtained from the widely-spaced twin screws and rudders.



The new floating crane "Samson."

This is the latest of a number of floating cranes built by Simons-Lobnitz Ltd.; the structural and mechanical parts of the crane were manufactured by Cowans Sheldon and Co. Ltd., and the main electrical machinery by The General Electric Co. Ltd.

New British Fire Protection Development

Turners Asbestos Cement Company have reported successful tests on the application of asbestos ships board for the protection of aluminium decks against fire. This achievement is important because it will allow shipbuilders to use aluminium deck members in their vessels instead of mild steel, thus giving a much lighter superstructure. Independent tests on the new method have been carried out by the Department of Industrial and Scientific Research.

Sections of aluminium deck protected by the new method were heated from below for an hour. After five minutes the temperature had risen to 600°C. It continued to increase until it was well over 900°C but, at the end of the hour, the temperature on the upper surface of the deck had only risen to a little more than 100°C. Successful completion of this test means that the material has achieved the standards laid down in the International Convention for the Safety of Life at Sea for fire resisting divisions on passenger ships.

Floating Pneumatic Grain Elevator for Hull

Simon Handling Engineers Ltd. of Stockport, have placed an order with Messrs. Richard Dunston Ltd., to build the pontoon for the 300 tons per hour capacity Pneumatic Grain Elevator ordered by The British Transport Commission, Hull, as part of the modernisation scheme to enable larger grain ships to be discharged more efficiently, and to speed the turn-round of shipping in King George Dock.

The pontoon will be built at the Hessle Shipyard and will be 87-ft. 6-in. long x 39-ft. Mld. breadth x 14-ft. Mld. depth and is due to be launched in November 1961.

Recent Contracts

Substructure and Foundations of New Severn Bridge

The Ministry of Transport has placed a contract valued at approximately £2 million with John Howard & Company Ltd., the Civil Engineering Contractors, for the sub-structure and foundations of the new Severn Bridge. The work will begin very shortly and this contract is expected to last 24 months.

The first phase which contains all the heavy civil engineering work on the bridge, will consist of:—(a) two piers, founded on rock, approximately 140-ft. x 42-ft. x 63-ft. high, including deep excavations under water level to bedrock; (b) cable anchorages, which will be two massive concrete structures 163-ft. x 123-ft. x 150-ft. high, in which will be embedded steelwork for resisting the tension of the two main bridge cables; (c) a viaduct at Aust, the total length of which will be 513-ft., comprising three spans at the east end of the bridge; (d) a breakwater at Beachley to facilitate ferry berthing during the construction of the Bridge.

The new Severn Bridge, which will be a suspension bridge, will have a main span of 3,240-ft., together with two side spans each 1,000-ft. long. It will be only 60-ft. shorter than the Forth Road Bridge and will thus be the second largest suspension bridge in Europe and the fifth largest in the world.

Floating Dock for Poland

Furness Shipbuilding Co. Ltd., of Haverton Hill-on-Tees, have entered into a contract with "Centromor", the Polish Government organisation for the import and export of ships, floating docks and marine equipment, to build a 5,500 tons lifting capacity box type floating dock for delivery during 1961.

The dock is to be designed by Clark and Standfield Ltd., London, well known as designers of floating docks. It will have an overall length of 450-ft. and a width of 93-ft. 6-in. and will form an important addition to the already extensive ship-repairing facilities controlled by United Ships Repair Yards of Poland.

Contracts for Level Luffing Tower Cranes

Butters Bros. & Co. Ltd. have recently secured several contracts for the latest design of their shipyard level luffing tower cranes. One order for Canada, valued at some £200,0000, is for a 75-ton shipyard crane and 75-ton electric overhead travelling cranes; another contract is for a 40-ton shipyard crane for Poland, valued at approximately £100,000. Further orders to the value of some £500,000 have been secured in the last few weeks from British shipyards and, two 7½-ton level luffing cranes are to be incorporated on the floating dock which the Furness Shipbuilding Co. Ltd. is supplying to Poland and which is mentioned above.

CLASSIFIED ADVERTISEMENTS

Rates 4s. per line (minimum 8s.): Box Number 2s. extra: Rate for single column inch is £2 per inch. Prepayment of classified advertisements is requested. Orders should be sent to Advertisement Department, "The Dock and Harbour Authority," 19. Harcourt Street, London, W.1. Telephone: PAD 0077.

APPOINTMENT VACANT

BELFAST HARBOUR COMMISSIONERS

The Belfast Harbour Commissioners invite applications for a suitably qualified assistant civil engineer (age 25/35 years).
The appointment will be temporary, but it is expected to be for a period of not less than 2 years.
Salary will be in accordance with qualifications and experience.
Duties will include supervision of contract works involving piling, foundations, etc., for quay and wharf construction, and also direct labour works comprising setting out and construction of roads, ancillary works, etc.
Applications, stating age, qualifications, etc., must be addressed to the undersigned, and endorsed "Temporary Assistant Engineer."
Canvassing in any form, either direct or indirect, will disqualify.

Harbour Office, BELFAST. F. W. P. HAMPTON, General Manager and Secretary.

FOR SALE

ABERDEEN HARBOUR BOARD

COALING INSTALLATION PLANT (10 years old) for immediate disposal comprising four bunkering points with 3 large and 2 small hoppers, electrically-operated belt conveyors and chutes, complete with weigh-gear and the necessary auxiliary electrical equipment; all in steel construction and in first-class order; also suitable for handling other minerals; may be disposed of as an installation or as separate units. For further particulars apply to the undersigned with whom tenders should be lodged.

Harbour Office, ABERDEEN. NORMAN R. BEATTIE, General Manager and Secretary.

Exclusively in our Hands for Sale

The self-propelled suction-hopperdredger BZZ-5280, suitable for suction from the bottom delivering the spoil in her own hopperhold and also suitable to deliver the spoil ashore from her own hopperhold over a distance of about 800 m. Built 1912, dims.: 60,35 x 10,20/9,80 x 5,15 m.—Class: Bureau Veritas—last s.s.: April 1959—gross/net 806/446,77 reg. tons—max. draft loaded 4,80 m.—max. hopperhold-capacity: 690 m^3—dredging depth: 20 m. —ø suctionpipe/deliverypipe: 70/60 cm. Main engine 600 HP triple expansion — oil firing system Todd—2 boilers renewed 1947—H.S. 2 x 115,2 m^2—W.P. 11,9 atm. Bunkercapacity 45 tons oil—speed loaded 8 knots—one propeller.

Prompt delivery in Holland can be arranged. Price on application.

For further information please apply to

Scheepsmakelaarskantoor J. Verheul, Scheepmakershaven 53, Rotterdam—phone 134735 (2 lines); grams Jeverheul; Telex 21402.

WANTED

BALL AND ROLLER BEARINGS ETC. WANTED. Also surplus goods —especially Hand Tools—of all descriptions. R. Pordes, 138 New Cavendish Street, London, W.1. MUSeum 5250.

TENDERS

OFFICE OF PUBLIC WORKS

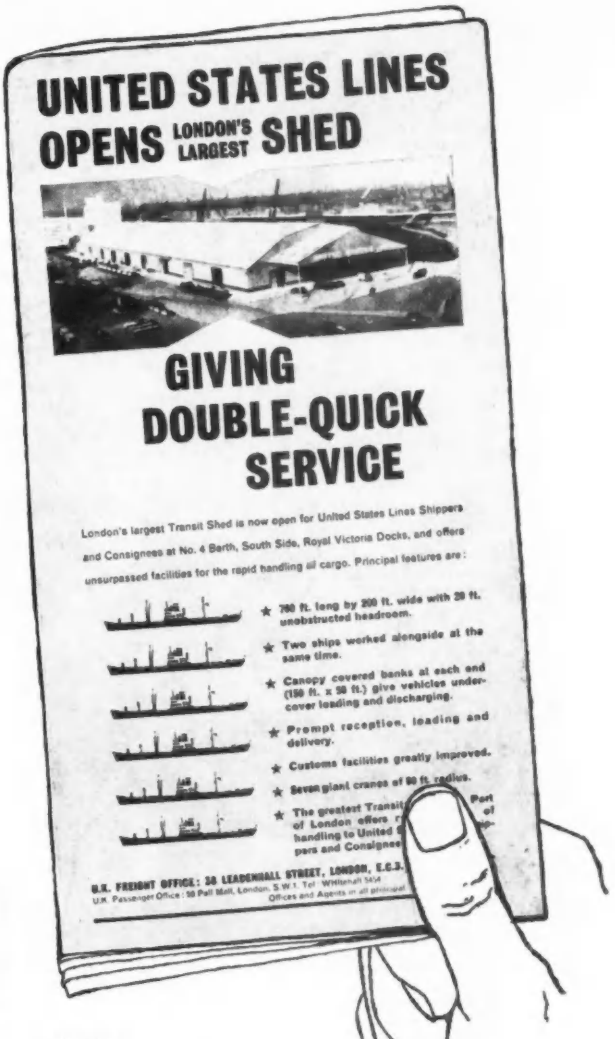
Sealed tenders addressed to the Secretary, Office of Public Works, 51 St. Stephen's Green, Dublin 2 and receivable up to noon on 23rd May, 1961, are invited for trial borings at the following harbours: Howth, Passage East, Castletownbere and Galway, in accordance with plans, specification and conditions of contract exhibited at this office.
Plans and specification may be obtained from the Secretary on deposit of £5, refundable on return of the documents.
The lowest or any tender will not necessarily be accepted.

N.A.T.O. COMMON INFRASTRUCTURE
SLICE VIII
NAVAL BASE INSTALLATIONS

1. FINAL NOTICE is hereby given that International Competitive Bids will be invited on or about 1st July, 1961, for construction of a JETTY associated with a P.O.L. STORAGE DEPOT in the CAMBPELTOWN AREA OF SCOTLAND.
2. The approximate total value of the Jetty works is £250,000 and the Jetty and its approach spans will be constructed of reinforced concrete supported upon steel box piles.
3. A separate Final Notice in respect of P.O.L. Storage Depot has been issued. Pipework and terminal facilities on the Jetty will form part of the contract for the P.O.L. Storage Depot.
4. It should be noted that importation of labour from sources outside the United Kingdom may be subject to restriction and that permission could, in any case, only be given on an undertaking that the Contractor would pay rates of wages and observe hours and conditions of labour not less favourable than those established for U.K. labour for the trade or industry in the same area.
5. Closing date for the receipt of bids will be 31st August, 1961.
6. Firms wishing to bid must formally notify their desire by applications to the address below by **1st May, 1961.**
7. Within one week after the closing date for the receipt of applications to bid, firms wishing to be invited must forward the following information:—
   (i) Statement of financial resources and evidence of financial stability.
   (ii) Details of recent major contracts completed for work of a comparable nature including an indication of the value of each.
8. Enquiries regarding bidding should be addressed to:—
   DIRECTOR GENERAL, NAVY WORKS, ADMIRALTY,
   CHAMBERLAIN WAY, PINNER,
   MIDDLESEX, ENGLAND.
   quoting reference NWD/Infra/19 (Jetty).

STOTHERT & PITT CRANES PROVIDE THE "DOUBLE QUICK SERVICE"

The opening of the new berth and four-acre shed built for United States Lines at Royal Victoria Dock, Port of London, provides "unsurpassed facilities for the rapid handling of cargo" — a claim fully backed up by the seven Bath built cranes. The four 5-ton and three 3-ton cranes, each with a radius of 80 ft., can serve two berths simultaneously, giving a considerable saving in handling time and running costs.


UNITED STATES LINES OPENS LONDON'S LARGEST SHED

GIVING DOUBLE-QUICK SERVICE

London's largest Transit Shed is now open for United States Lines Shippers and Consignees at No. 4 Berth, South Side, Royal Victoria Docks, and offers unsurpassed facilities for the rapid handling of cargo. Principal features are:

★ 700 ft. long by 200 ft. wide with 20 ft. unobstructed headroom.

★ Two ships worked alongside at the same time.

★ Canopy covered banks at each end (150 ft. x 50 ft.) give vehicles undercover loading and discharging.

★ Prompt reception, loading and delivery.

★ Customs facilities greatly improved.

★ Seven giant cranes of 80 ft. radius.

★ The greatest Transit ... of London offers ... handling to United ... pers and Consignees

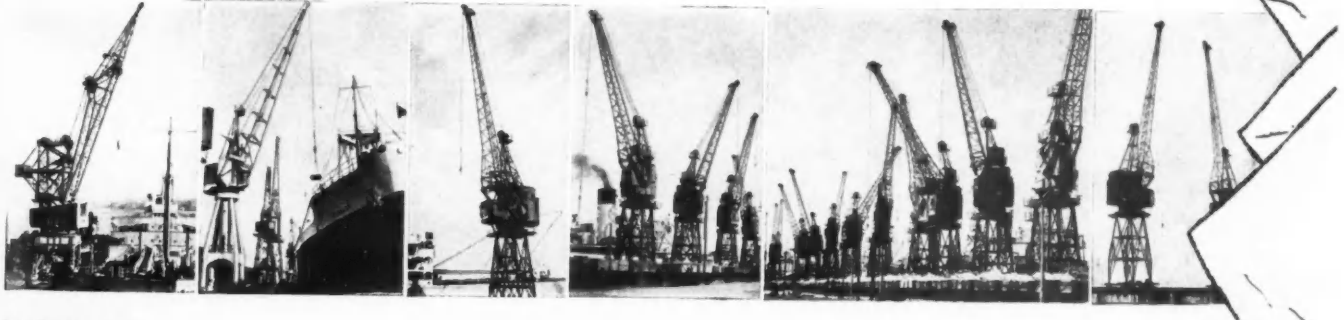
U.K. FREIGHT OFFICE: 38 LEADENHALL STREET, LONDON, E.C.3.

U.K. Passenger Office: 50 Pall Mall, London, S.W.1. Tel: Whitehall 5454

Offices and Agents in all principal ...

ABOVE
Advertisement in "The Times" dated April 5th 1960.

BELOW
Stothert & Pitt cargo handling cranes at work in ports all over the world.



S&P LIMITED

STOTHERT & PITT LTD · ENGINEERS · BATH

LONDON OFFICE: 38 Victoria Street, S.W.1.

MIDLANDS OFFICE: Lightning Way, Alvechurch Road, West Heath, Birmingham 31

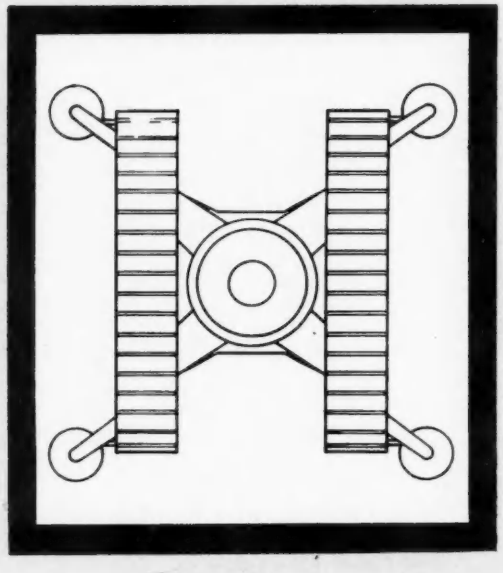
S.P. 122

Phenomenal!

It weighs only 79,000 lb

-yet it lifts 90,000 lb

Nothing, anywhere in the world, approaches
this superb machine. Unrivalled in its performance.
Unrivalled in its time saving versatility.
Unrivalled in its never-say-die reliability.



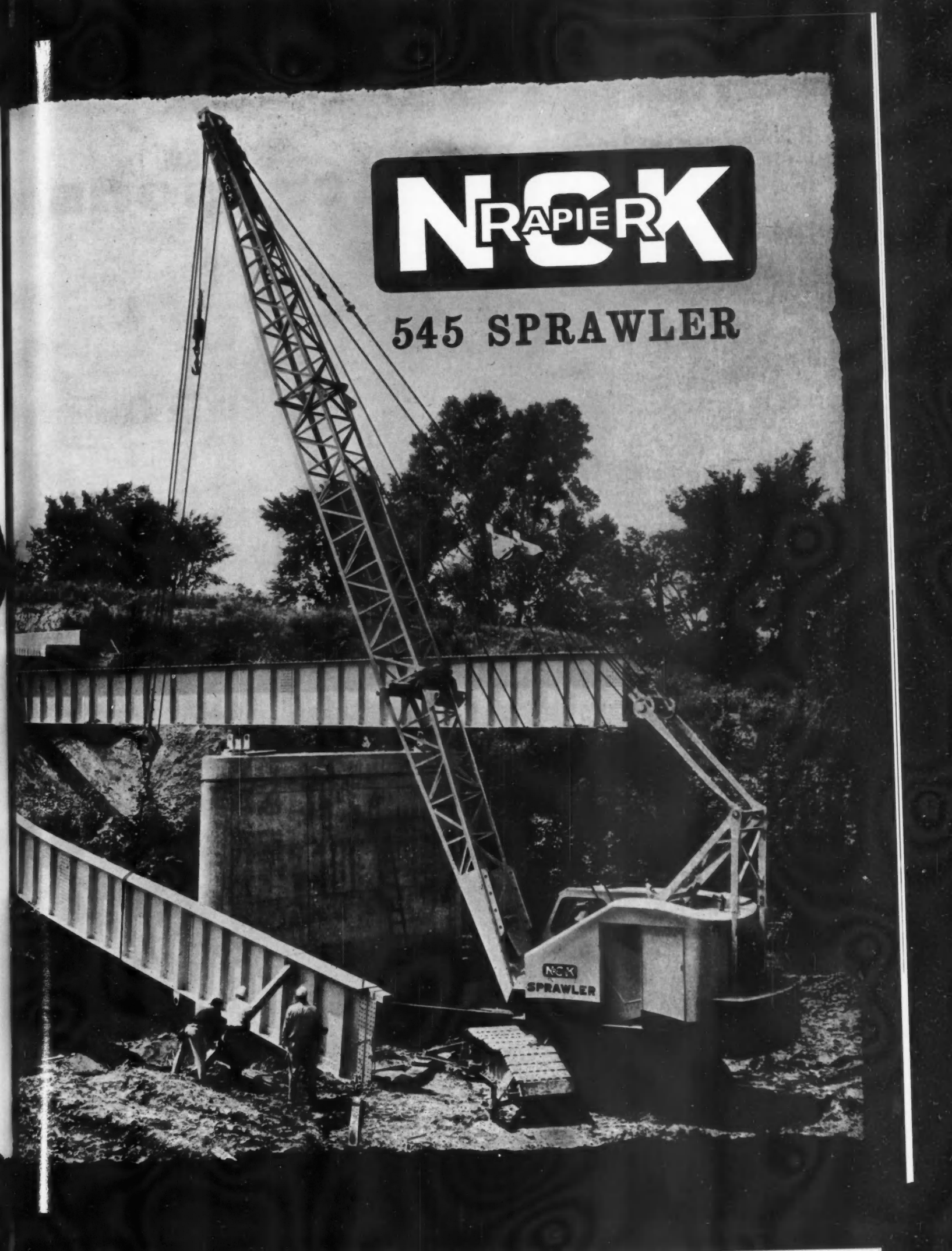
Lifts up to 90,000 lb (with outriggers set)
Booms up to 120 ft
Weighs only 79,000 lb (with 40 ft boom)
Stripped of boom and counterweight—weighs only 51,000 lb
Easily transportable on low loader
Height reducible to 12 ft 5 in
Convertible to dragline or grabcrane

See it at the Public Works Exhibition, Stand No. 42
or get full technical details from

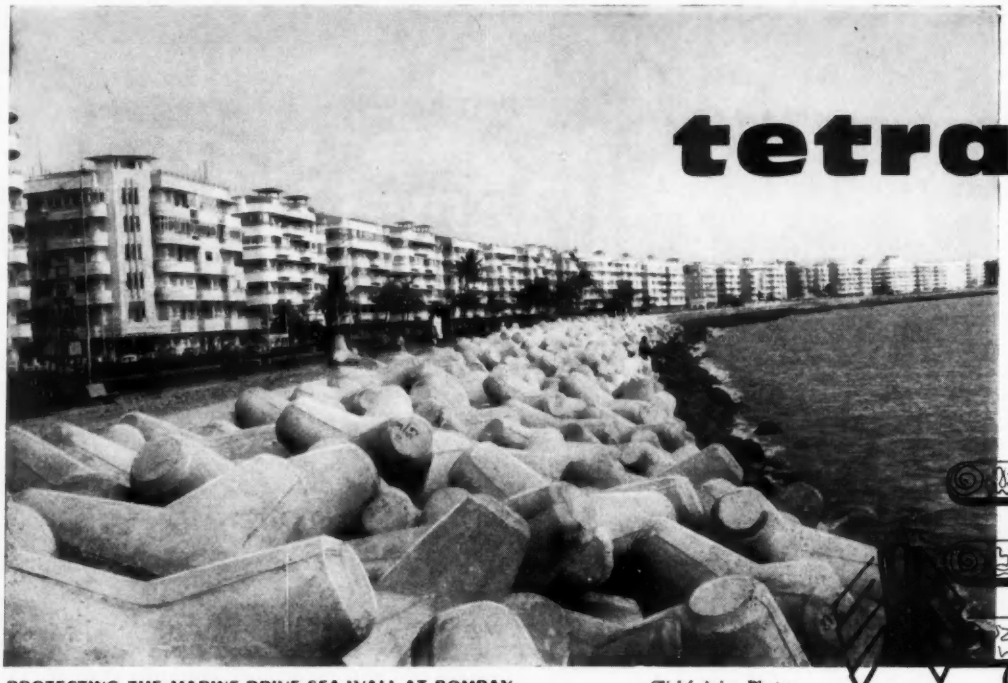
NCK-RAPIER Limited

32 Victoria Street, London, S.W.1
TELEPHONE ABBEY 6738/9 CABLES EXCASALES LONDON

A Newton Chambers Company


RAPIER
545 SPRAWLER
SPRAWLER

tetrapods

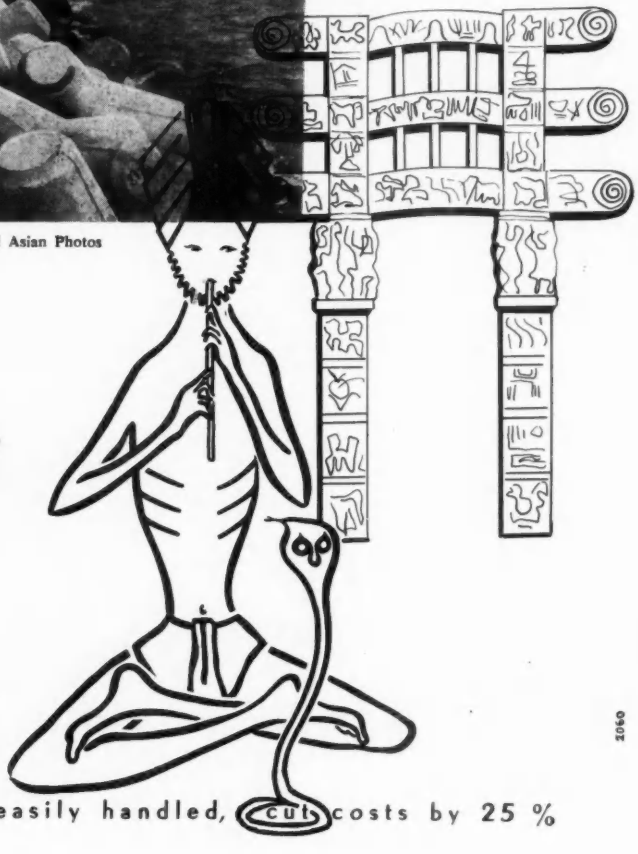


PROTECTING THE MARINE DRIVE SEA-WALL AT BOMBAY
Some 7,000 concrete tetrapods are being installed along the 4,000 ft long sea-wall of Bombay's famous Marine Drive. Each tetrapod weighs 3·8 tons

Cliché Asian Photos

protect

BOMBAY



engineers prefer
tetrapods

because they are more reliable, are easily handled, cut costs by 25 %

it is hard to beat tetrapods when it comes to protecting rubble mound breakwaters. Their sturdy legs interlock forming a tough armour that can be depended upon for its roughness, permeability and stability.

Conventional breakwaters cannot stand comparison with equally strong breakwaters using tetrapods because of the great savings in . .

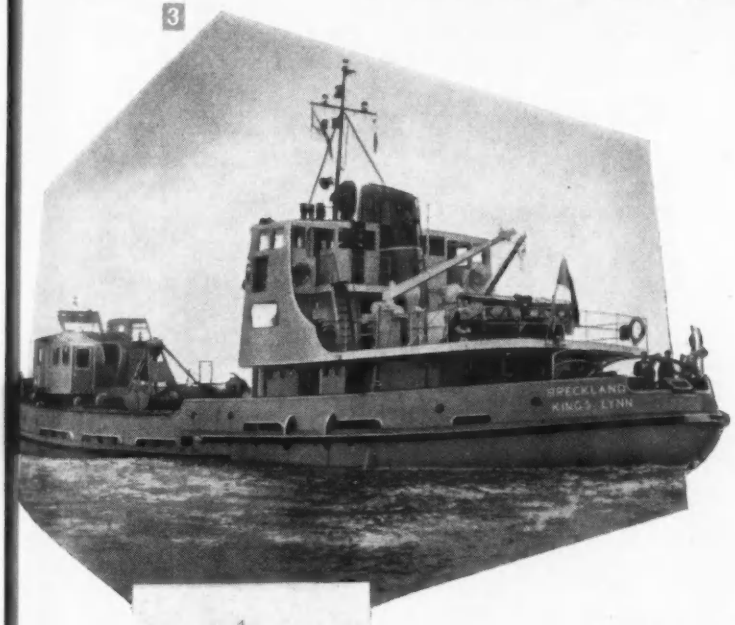
. . . the total amount of material involved in the breakwater, the amount of concrete used handling equipment.

SOTRAMER

SOTRAMER
Rue Paul-Verlaine
B P 59 · Telephone 44 55 50
GRENOBLE · FRANCE

HYDRAULICS

for Hopper Dredgers...



1. **TWIN GRAB HOPPER DREDGER "RHYMNEY"**
built by Charles Hill & Sons Ltd., for British Transport Commission, South Wales Docks, fitted with Hand and Power Electric Hydraulic Steering Gear and Hydraulic Hopper Door Operating Equipment.

2. **GRAB HOPPER DREDGER "CURRAGHGOUR II"**
built by Liffey Dockyard Ltd., for Limerick Harbour Commissioners, fitted with Hand and Power Electric Hydraulic Steering Gear, Hydraulic Hopper Door Operating Equipment and Deck Machinery.

3. **GRAB HOPPER DREDGER "BRECKLAND"**
built by Richard Dunston Ltd., for British Transport Commission, Kings Lynn, fitted with Hand and Power Electric Hydraulic Steering Gear and Hydraulic Hopper Door Operating Equipment.

4. **GRAB HOPPER DREDGER "LANDGUARD"**
built by Goole Shipbuilding & Repairing Co. Ltd., for British Transport Commission, Harwich, fitted with Hand and Power Electric Hydraulic Steering Gear and Hydraulic Hopper Door Operating Equipment.

STEERING GEAR
DECK MACHINERY
HOPPER DOOR
OPERATING EQUIPMENT

VICKERS-ARMSTRONGS

VICKERS-ARMSTRONGS (ENGINEERS) LTD
MARINE EQUIPMENT DIVISION
Full Technical Information Supplied on request to
Registered Offices and Sales Department: ***VICKERS HOUSE BROADWAY LONDON SW1 TEL. ABBEY 7777***
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Direct communication with - and between - ships under way saves time and money, increases safety and efficiency, and improves service to passengers.

527-E

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VHF MOBILOPHONE means a TELEPHONE ON BOARD.

For ALL classes of shipping there are now various facilities EVEN IN TERRITORIAL WATERS for (radio)telephone calls between shore and ship and between individual ships. PHILIPS VHF MOBILOPHONES are in ever-increasing demand for use in international maritime VHF networks, the International Rhine Navigation network and numerous public and private networks, both aboard ships and ashore. A telephone on board is an indispensable aid for any up-to-date vessel.

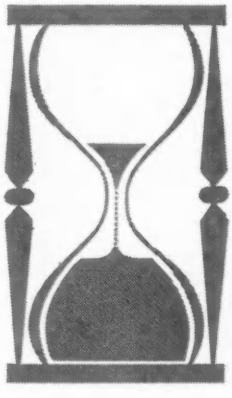
N.V. PHILIPS' TELECOMMUNICATIE INDUSTRIE •

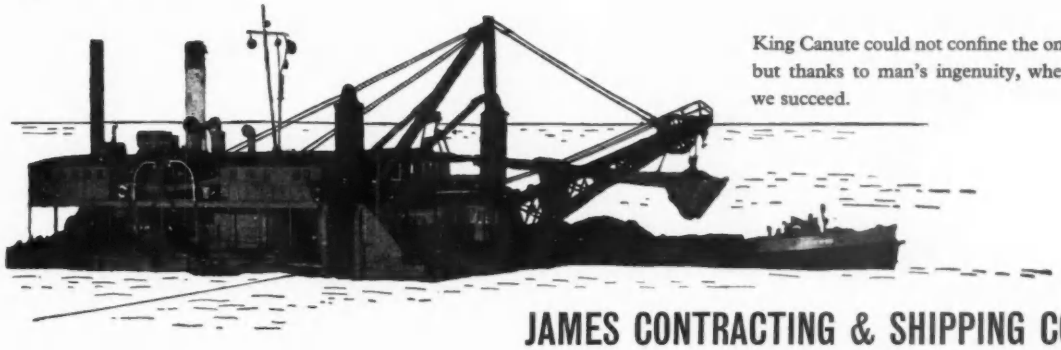
P.O.Box 32 - Hilversum - The Netherlands.

Canute reproving his courtiers at Southampton, from a painting by Lorentz Frolich.

"Nae Man can tether Time or Tide"

The poet's words are as true today as they ever were, man still pits himself in endless war against the sea. Man cannot relax in this struggle — though he sleeps the sea never rests — the tide rips ceaselessly at the sea wall — rivers carry their burden of silt to the estuaries, — winter winds and tides bring mountainous seas that flood the land, and leave desolation in their wake. To tether the tides and tame the sea — reclaim the land and keep harbours and channels clear, potent tools are needed — we can provide these tools — together with the skills gained during many years of unremitting war against the sea in all parts of the world.





King Canute could not confine the oncoming tide, but thanks to man's ingenuity, where he failed, we succeed.

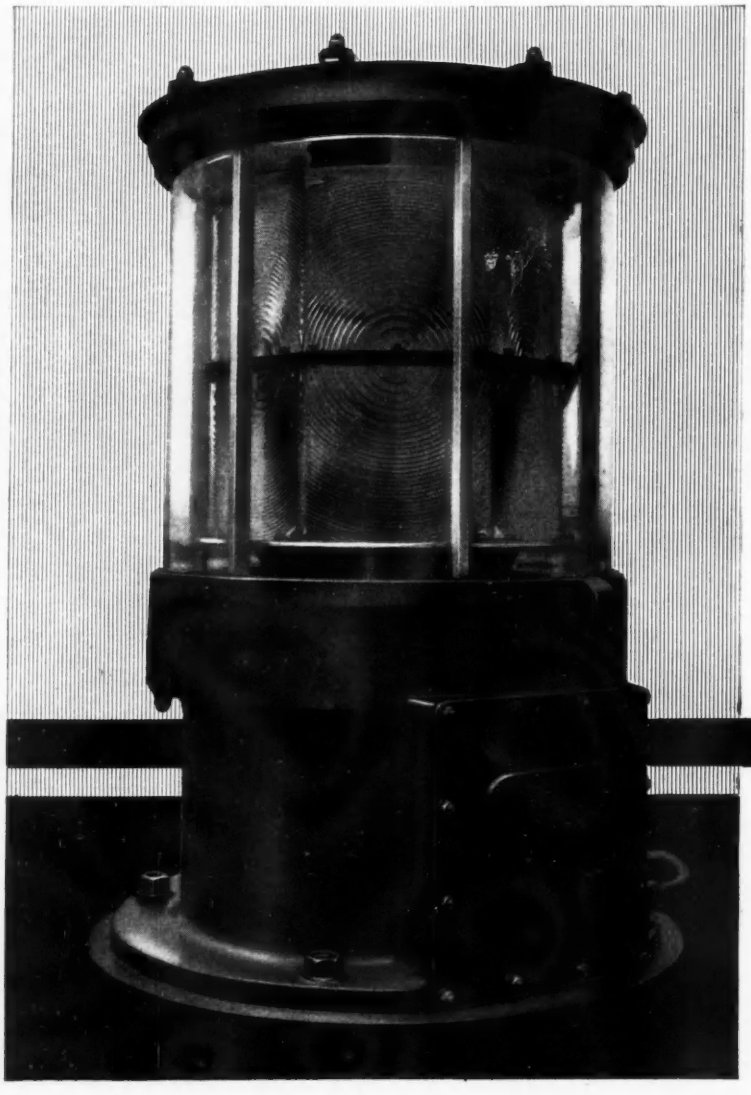
JAMES CONTRACTING & SHIPPING CO. LTD.

DREDGING AND LAND RECLAMATION SPECIALISTS

JAMES WHARF, SOUTHAMPTON. TELEPHONE: 22436/7 TELEGRAMS: TOWING SOUTHAMPTON

AP16

Working from mains or battery, this STONE-CHANCE POWER BEAM BEACON can give a 9650 candle-power flash every 5 seconds for 12 months WITHOUT ATTENTION



The Stone-Chance **POWER BEAM BEACON** can flash any one of over fifty different characters, reliably and economically, in any climate, for months and months without attention. It can do this because it's a revolving-beam beacon and therefore easier on current. Because its lenses are fully-stabilised clear plastic and therefore lighter than glass. Because these lenses are in two tiers, and adjustable. Because it incorporates an automatic lamp-changer. And because it is climate-proof.

The Dock & Harbour Authority

Would you like to know more about Power Beam Beacons?

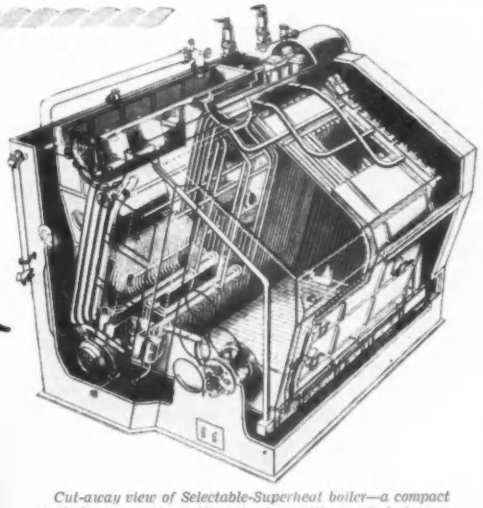
—Write to **STONE-CHANCE LTD**

THE LIGHTHOUSE ENGINEERS

SCHOMBERG HOUSE, 82 PALL MALL, LONDON, S.W.1

Babcock Selectable-Superheat boilers again, and this time for the largest tanker built in Britain—the 65,000 d.w. ton tanker "Serenia", launched from the Walker Naval Yard of Vickers-Armstrongs (Shipbuilders) Ltd., for Shell Tankers Ltd.
The main machinery, supplied and fitted by Vickers-Armstrongs (Engineers) Ltd., Barrow-in-Furness, includes two Selectable-Superheat boilers to supply steam for the main turbines, at a pressure of 650 lb./sq.in. and temperatures up to 900 F; and for auxiliary services.
"Serenia" joins an impressive "fleet" of modern merchant and naval vessels equipped with

BABCOCK *Marine* BOILERS



Cut-away view of Selectable-Superheat boiler—a compact single furnace unit providing simple, positive control of steam temperature by a system of differential dampers to adjust gas-flow through the "superheated" and "saturated" sections of the boiler. Well-proved in both naval and merchant service.

BABCOCK & WILCOX LTD., BABCOCK HOUSE, 209 EUSTON ROAD, LONDON, N.W.1

Tonnage up costs down with YALE Trucks

Yale Electric Trucks have played an important part in the Port mechanisation carried out by British Railways (Eastern Region) at Parkeston Quay on the Harwich, Rotterdam and Antwerp routes.

Palletisation of merchandise has cut what used to be a multi-manual operation, into a speedy simple operation with far less effort on the part of the workers. Despite a greatly increased tonnage turn-round time has been speeded, overall costs reduced and dockers' earnings increased.

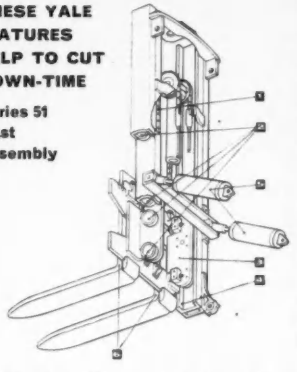
Yale Worksaver Trucks are used on board to move loads from the hatch to the wings and ends of the holds, when loading and vice versa when unloading.

Yale Series 51 fork trucks working on the quay, take the loads from the cranes into the sheds, where Yale hydraulic hand-lift trucks are also used for shorter movements.

The Yale Advisory Service will gladly give you advice on all aspects of materials handling. A free booklet describes the ranges of Yale trucks and hoists. Please write to the address below for a copy.

THESE YALE FEATURES HELP TO CUT DOWN-TIME

Series 51 Mast Assembly



1 Two plate-link lifting chains. Each can sustain up to 500% overload.

2 Roller mounted mast & carriage.

3 130" Lift from 83" high standard mast.

4 Rolled steel mast channels with thick flanges to resist deformation.

5 Tilt actuated by two double-acting, piston-type cylinders providing load rigidity.

6 Forks adjustable from 14½" to 37½".

YALE
REGISTERED TRADE MARK

THE WORLD'S LARGEST RANGE OF MATERIALS HANDLING EQUIPMENT

The YALE & TOWNE Manufacturing Company, Materials Handling Division, Dept. DH4, Wednesfield, Staffs.

HOOD HAGGIE—*over 170 years of ropemaking*

when **ROPE** *takes over the watch....*

Passengers and men on shore-leave have disembarked: darkness swiftly blots out quayside detail. Apart from the muted conversation of duty crew, the only sound is the stutter of waves along the waterfront, and the creak of — rope. Here's a crew member which rarely relaxes. The protection of vessels from the effects of wind and tide is a job for highly trusted rope. Which is why Hood Haggie's ropes are favoured for mooring (cargo handling, lifeboat falls and most marine applications) by leading owners throughout the world.

HOOD HAGGIE

a good name to tie up with

ROBIN HOOD *Hawsers, Warps and Towlines*

HADRIAN *Nylon, Terylene and Courlene, ropes, cords and twines*

MANILA, *HEMP, SISAL and COIR ropes*

FLEXIBLE STEEL WIRE ROPES

R. HOOD HAGGIE & SON LTD. CONDERCUM HOUSE 171 WEST ROAD NEWCASTLE UPON TYNE 5 TEL. 39111 TELEX 53-114

M 2.

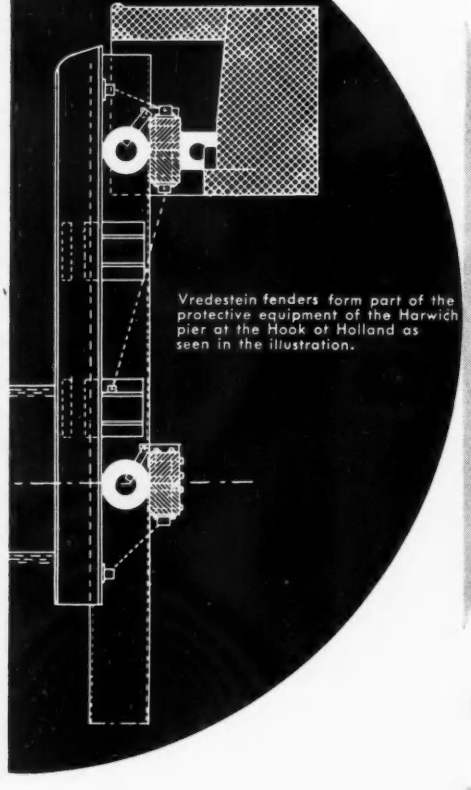
Vredestein, Holland

Specialists in the manufacture of rubber products for hydro-engineering

In ports the world over,
Vredestein dock-fenders are used to protect costly harbour installations. Vredestein's cylindrical and rectangular fenders, made of high-quality rubber, guarantee

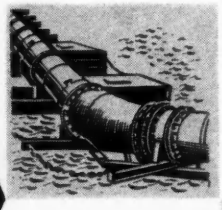
High energy-absorption,
Outstanding resilience
High resistance to climate conditions.

Vredestein can also supply fenders resistant to sea-water containing traces of oil.

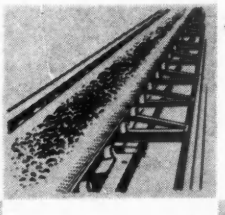


Vredestein fenders form part of the protective equipment of the Harwich pier at the Hook of Holland as seen in the illustration.

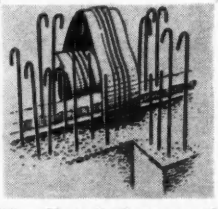
Vredestein have 50 years' experience and offer 15,000 high-quality products.



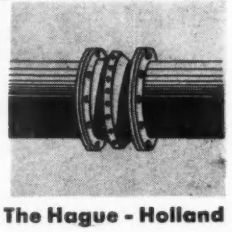
Dredging sleeves for suction and discharge and various other industrial rubber products for hydro engineering.



Various types of smooth and profiled belting for coal, iron-ore, etc.



Water-stops for concrete structures; steel strips are vulcanised into the rubber to render the construction perfectly watertight.



Expansion joints to take up the expansion in pipe lines.

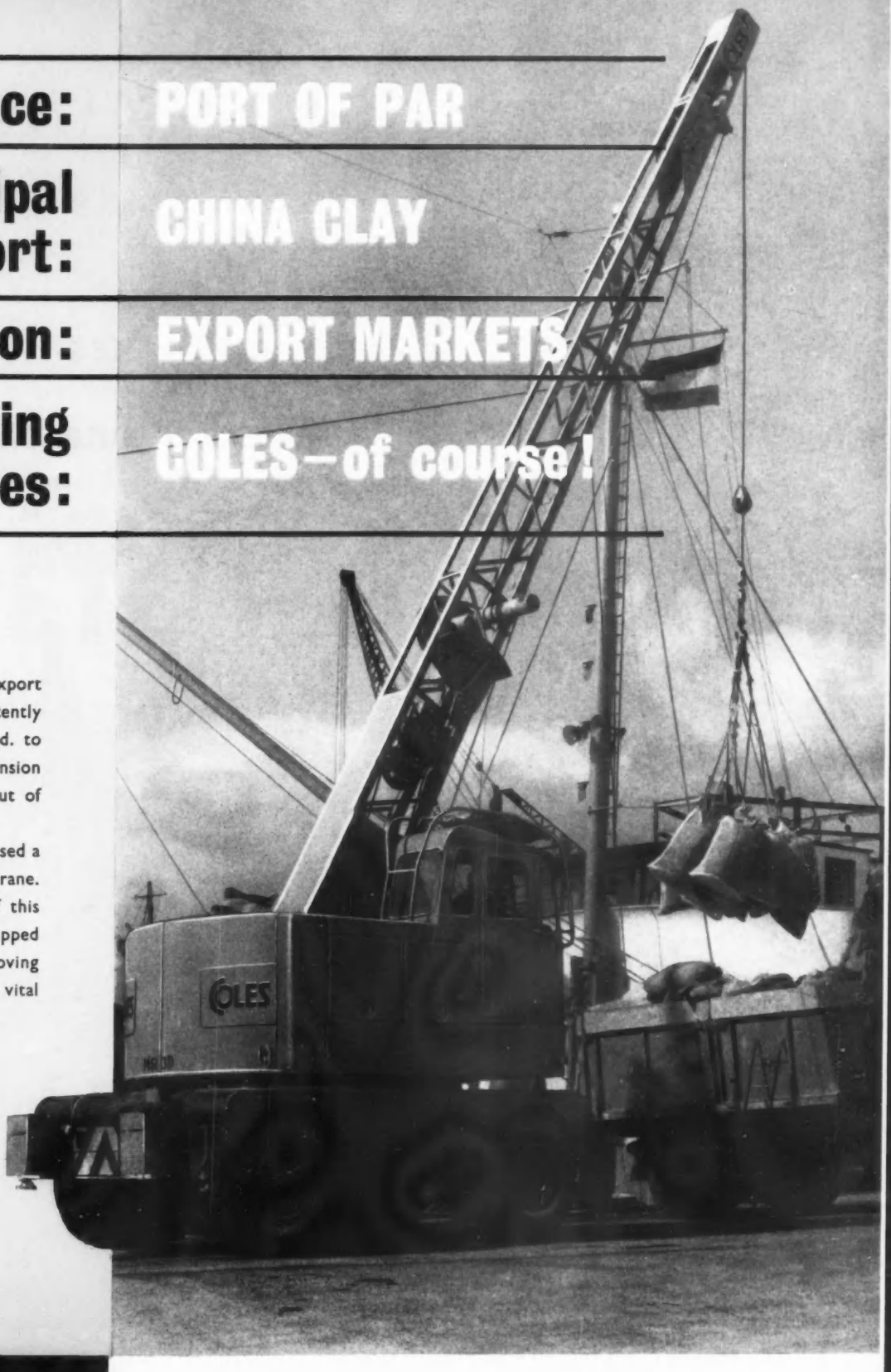
For further particulars and more detailed information please apply to: **Vredestein International, P.O. Box 55, The Hague - Holland**

Place: PORT OF PAR

Principal Export: CHINA CLAY

Destination: EXPORT MARKETS

Handling Facilities: COLES—of course!



Growing demand for bigger export shipments of china clay recently prompted English China Clays Ltd. to put in hand an ambitious expansion programme to increase throughput of their harbour at Par by 50%.

As part of this scheme they purchased a Coles "AENEAS" self-propelled crane. More than half a million tons of this valuable export commodity is shipped through Port of Par every year, proving in the process that Coles plays a vital part in small port prosperity too!

COLES* CRANES

THE NAME THAT CARRIES WEIGHT

STEELS ENGINEERING PRODUCTS LTD

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SALES AND SERVICE: LONDON, BRISTOL, BIRMINGHAM, MANCHESTER, LEEDS, NEWCASTLE, GLASGOW.

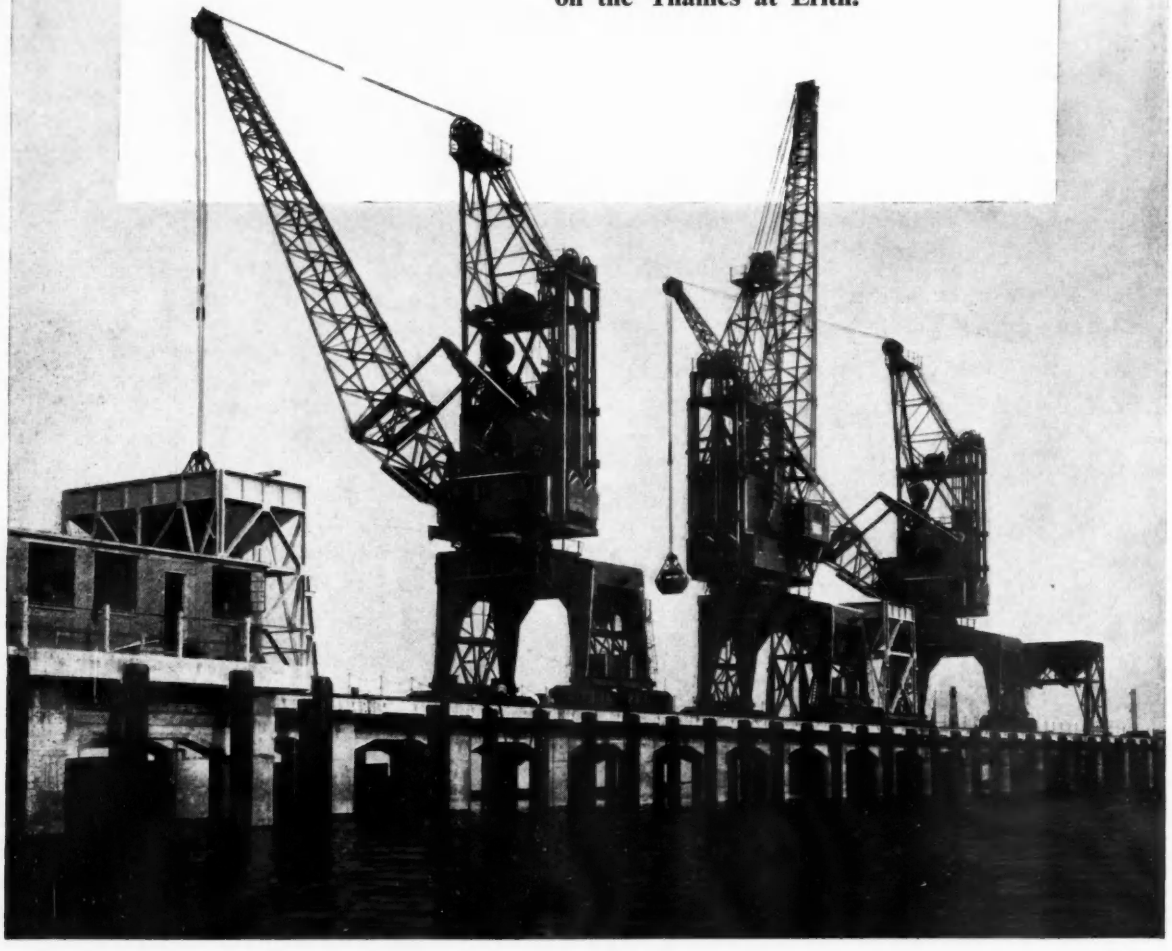
* Registered Trade Mark

688

HEAVY DUTY LEVEL
LUFFING GRABBING CRANES

FOR RAPID DISCHARGE OF BULK CARGOES

Clyde Cranes on the new coal transfer jetty of Messrs. William Cory & Son Ltd., on the Thames at Erith.



CLYDE BOOTH

CLYDE CRANE & BOOTH LTD.

incorporating

Clyde Crane & Engineering Co.,
MOSSEND, Lanarkshire.

Telephone: Holytown 412 (6 lines).
Grams: Clyde, Motherwell, Telex, Telex 77443.

Joseph Booth & Bros.,
Union Crane Works,
RODLEY, Leeds.

Telephone: Pudsey 3168 (6 lines).
Grams: Cranes Rodley Telex, Telex 55159.

R

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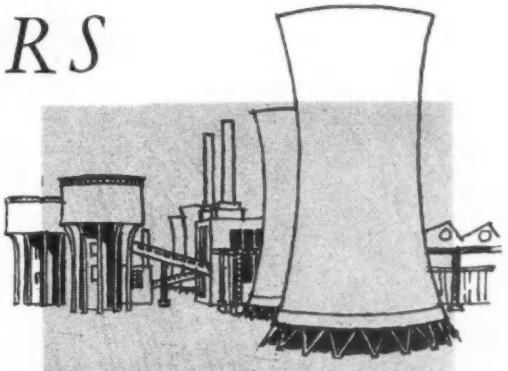

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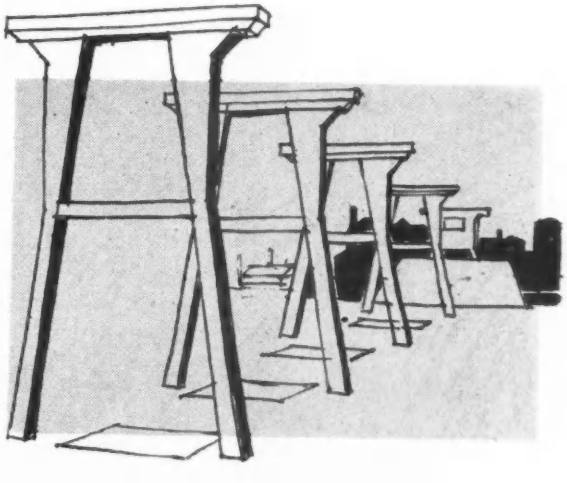
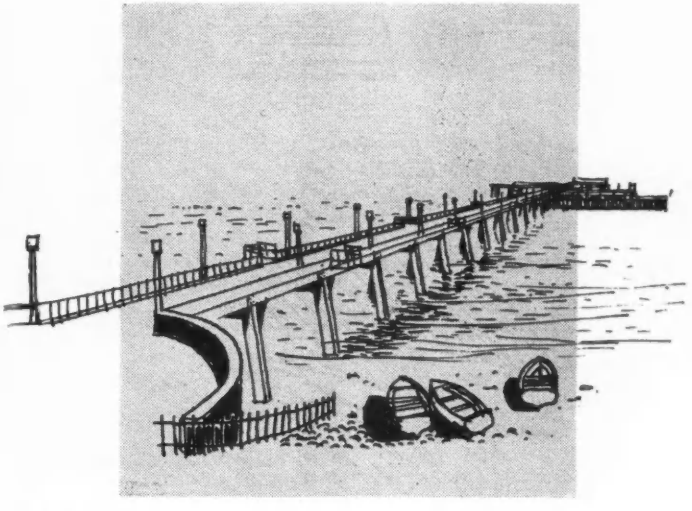
MINISTRY OF SUPPLY SHIPBUILDING AND HEAVY ENGINEERING INDUSTRIES

SPECIALISTS IN REINFORCED CONCRETE CONSTRUCTION





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ARTILLERY ROW, LONDON, S.W.1
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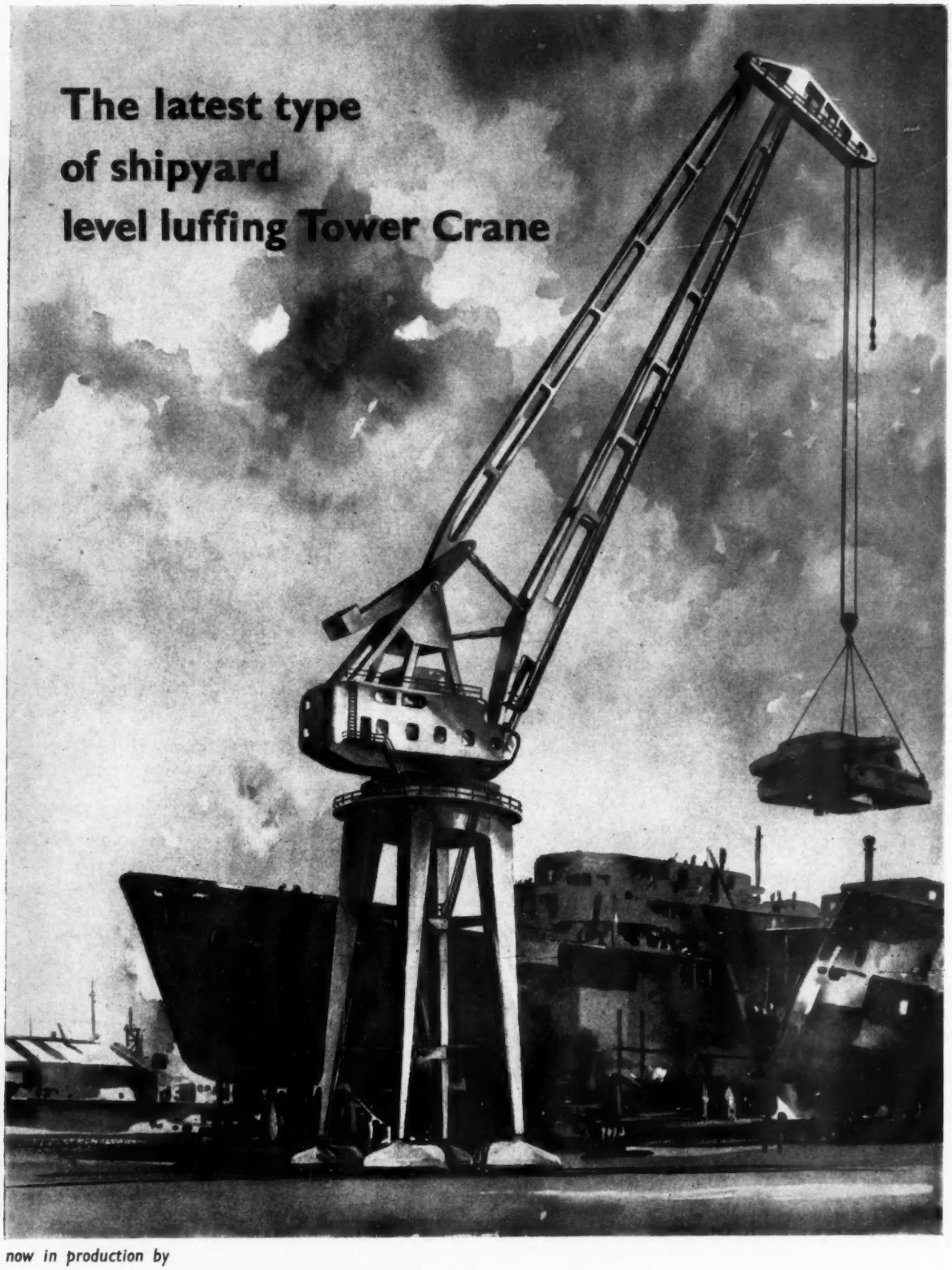


now in production by

BUTTERS BROS. & CO. LTD.

MACLELLAN STREET, GLASGOW, S.1. LONDON: THE CRANE WORKS, LONG LANE, HILLINGDON, MIDDX., & AT BIRMINGHAM & NEWCASTLE

Diver preparing to descend with turbid water camera for survey of Shadwell Entrance Lock—Middle Cill.
(Photo: Courtesy of the Port of London Authority)

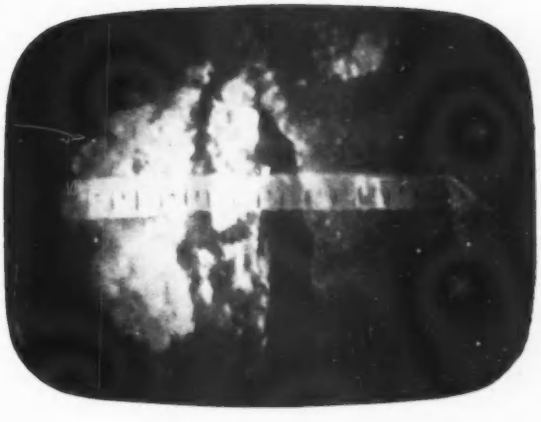
Underwater investigation by television

EVEN IN *TURBID* WATER!

Here is a service that will revolutionise underwater inspection. Offered by General Descaling Co. Ltd., this new service makes use of closed-circuit television. The camera used is unique in that it can see through **turbid** water—an ability not possessed by any other television camera nor, for that matter, by any diver. Think what this means! No longer need you rely on verbal reports from divers working 'blind,' working by touch . . . **you can see for yourself!** And you can have still or cine photographs of the screened transmissions for your permanent records.

For further information about this important new development, write or phone General Descaling.

Fissure in Jetty Wall.



SEE THIS NEW EQUIPMENT DEMONSTRATED at the Engineering, Marine, Welding & Nuclear Energy Exhibition, Olympia, April 20—May 4 on the GENERAL DESCALING STAND No. 4, ROW EE, FIRST FLOOR, EMPIRE HALL

SEWER AND PIPELINE INSPECTION BY TELEVISION TOO!

General Descaling also offer a new television inspection service for sewers and pipelines. For this work a different type of camera is used and pipes of down to 9-in. diameter can be inspected. A miniature version, suitable also for borehole inspection, is used for diameters down to 3-in. Full details on request.

General Descaling

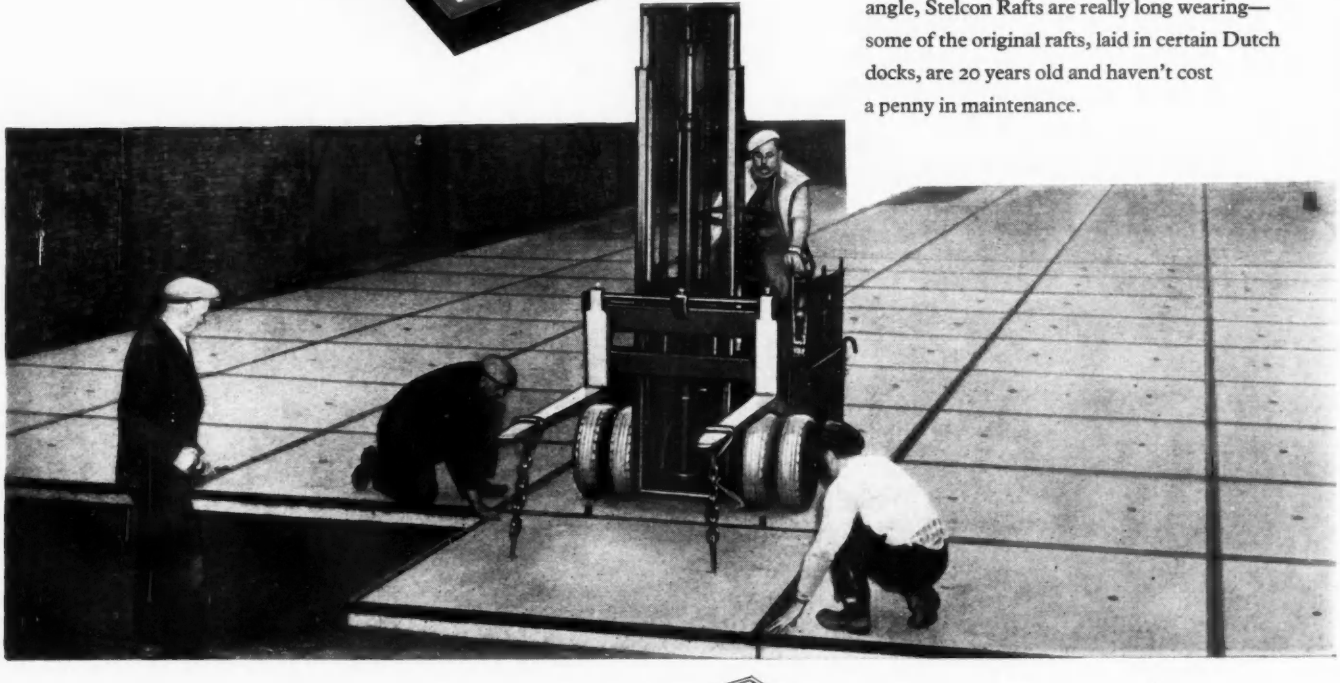
GENERAL DESCALING CO. LTD.
RETFORD RD., WORKSOP, NOTTS
Telephone: 3211. Telex: 54159.

Rafts save life ~~money~~!?

POINT ONE: Stelcon rafts are simply laid on a bed of sand or pea gravel, 300-500 sq. yds. in a day, so you can have a warehouse floor or a quay-side down *and* ready for traffic very, very quickly whatever the time of year.

POINT TWO: Where subsidence normally constitutes a problem, Stelcon Rafts can be simply picked up and re-laid to level, with very little interruption of work.

POINT THREE: Having a "steel clad" or "mineral clad" wearing surface, bound with mild steel angle, Stelcon Rafts are really long wearing—some of the original rafts, laid in certain Dutch docks, are 20 years old and haven't cost a penny in maintenance.



Stelcon Rafts

make steadfast floors

STELCON (INDUSTRIAL FLOORS) LTD · CLIFFORDS INN · LONDON EC4 · TELEPHONE: CHANCERY 9541

COWANS SHELDON

lower costs & raise standards with the

Cargomaster

REG'D TRADE MARK

LEVEL-LUFFING ELECTRIC DOCKSIDE CRANE

Cowans Sheldon revolutionise cargo-handling with the NEW CARGOMASTER level-luffing dockside crane. The CARGOMASTER brings down capital costs, operating costs, minimises maintenance, and provides a quicker "turn-round" than ever before achieved. This outstanding addition to the Cowans Sheldon range combines strength and economy in weight with the smooth sleek lines of tomorrow's design for the ports of today.

Characteristic advantages include:-

- ★ The operator, without leaving his seat, can lower the jib-head under full control to ground level.
- ★ Tubular steel jib.
- ★ Built-in telescopic service-crane handles all heavy machinery units, lowering to or lifting from quay-level.
- ★ Vertical flange-mounted, bogie-housed travel-motors, may be de-clutched for towing crane.
- ★ All-electric operation throughout provides safety, reliability, high efficiency and low operating cost.
- ★ Machinery for all motions except travel contained within Machinery House with hinged fibreglass roof-shell.
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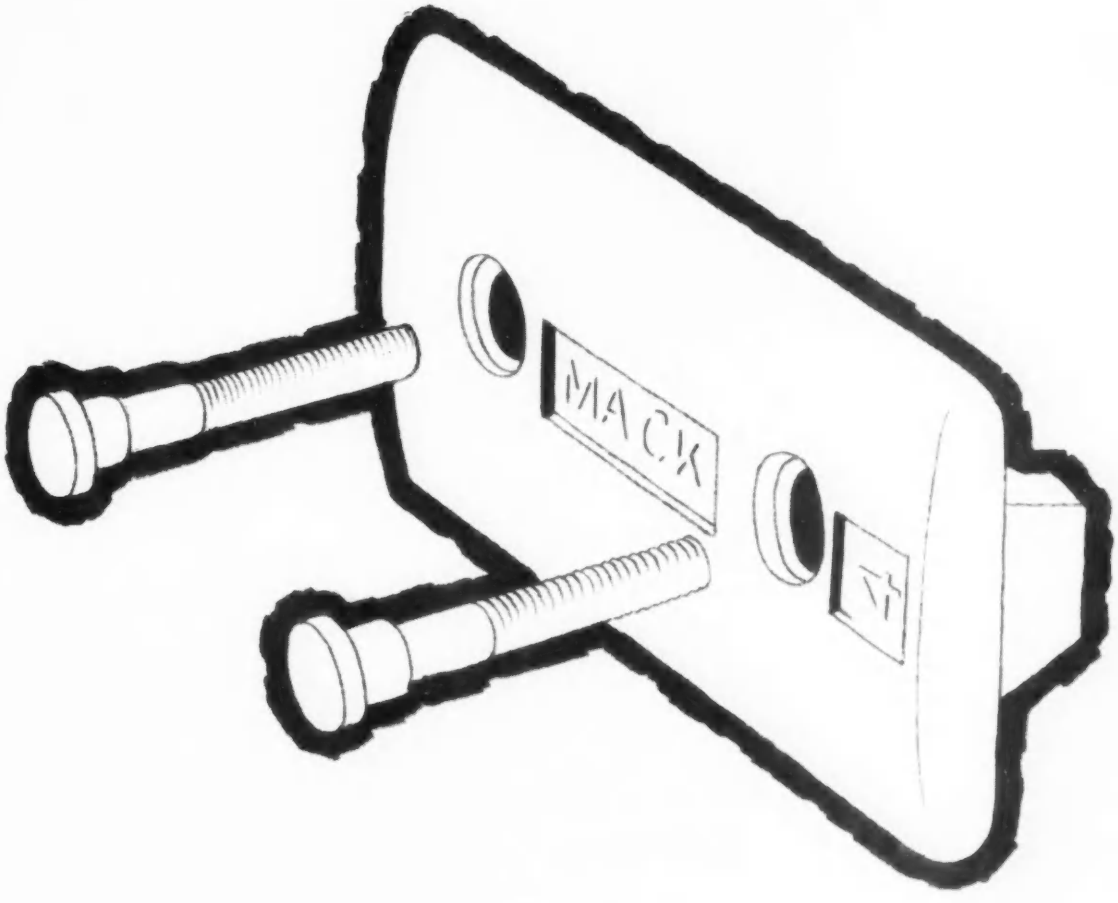

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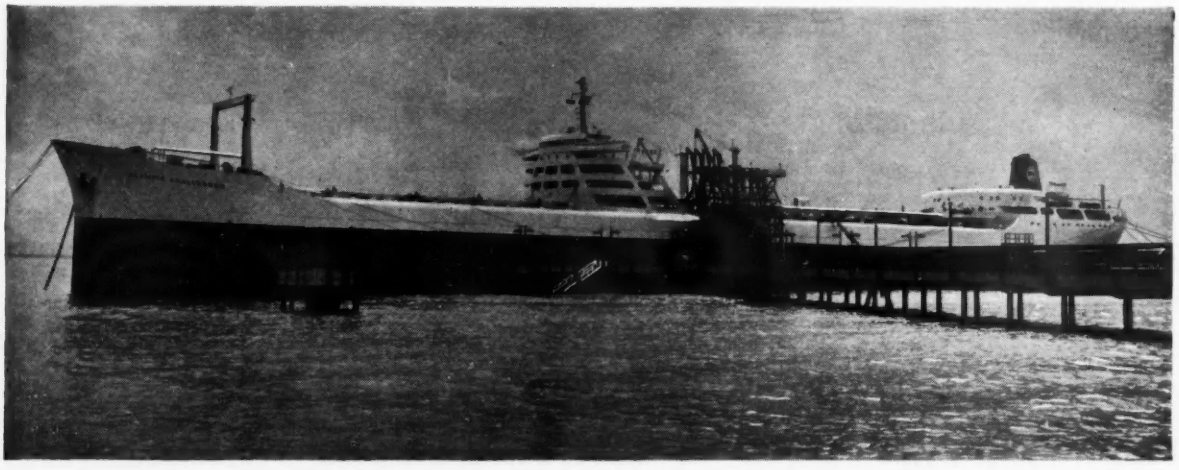

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Lower illustration: Woodfield six-unit Flow Boom Equipment, one of three installations in operation at Wilhelmshaven for the Nord-West Oelleitung gmbh

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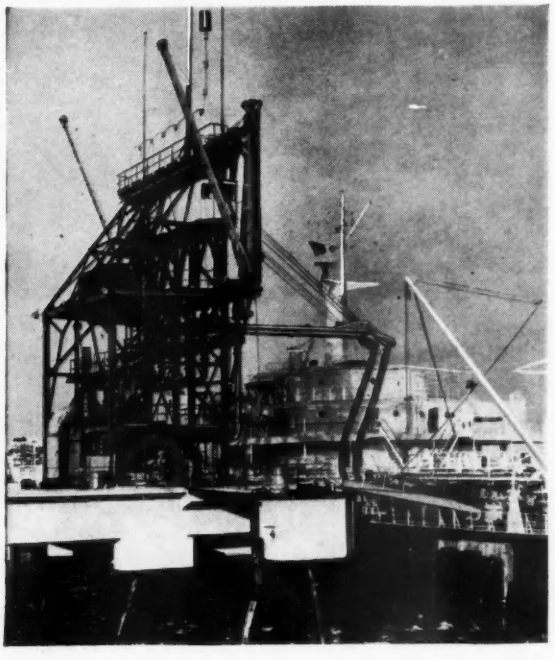

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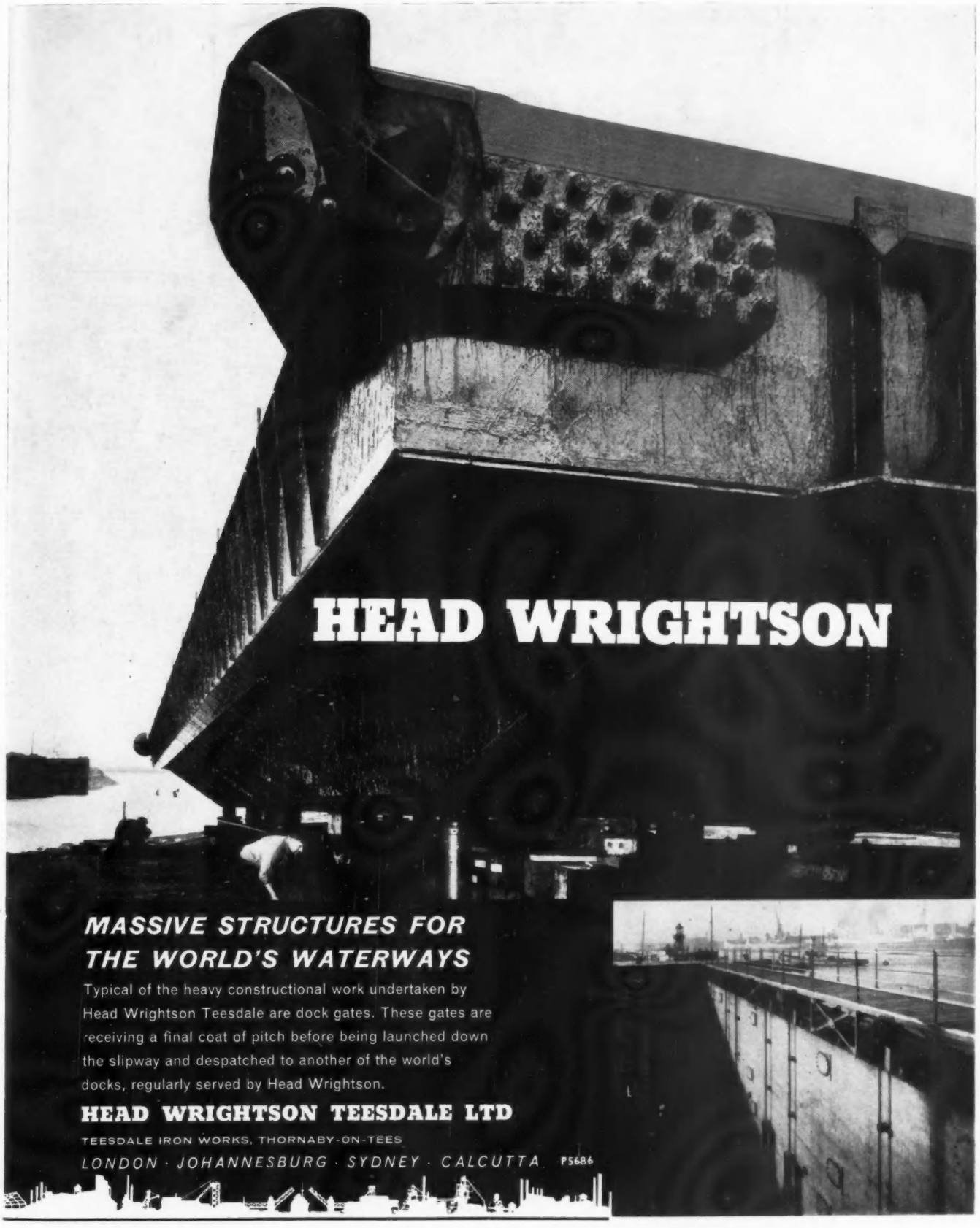
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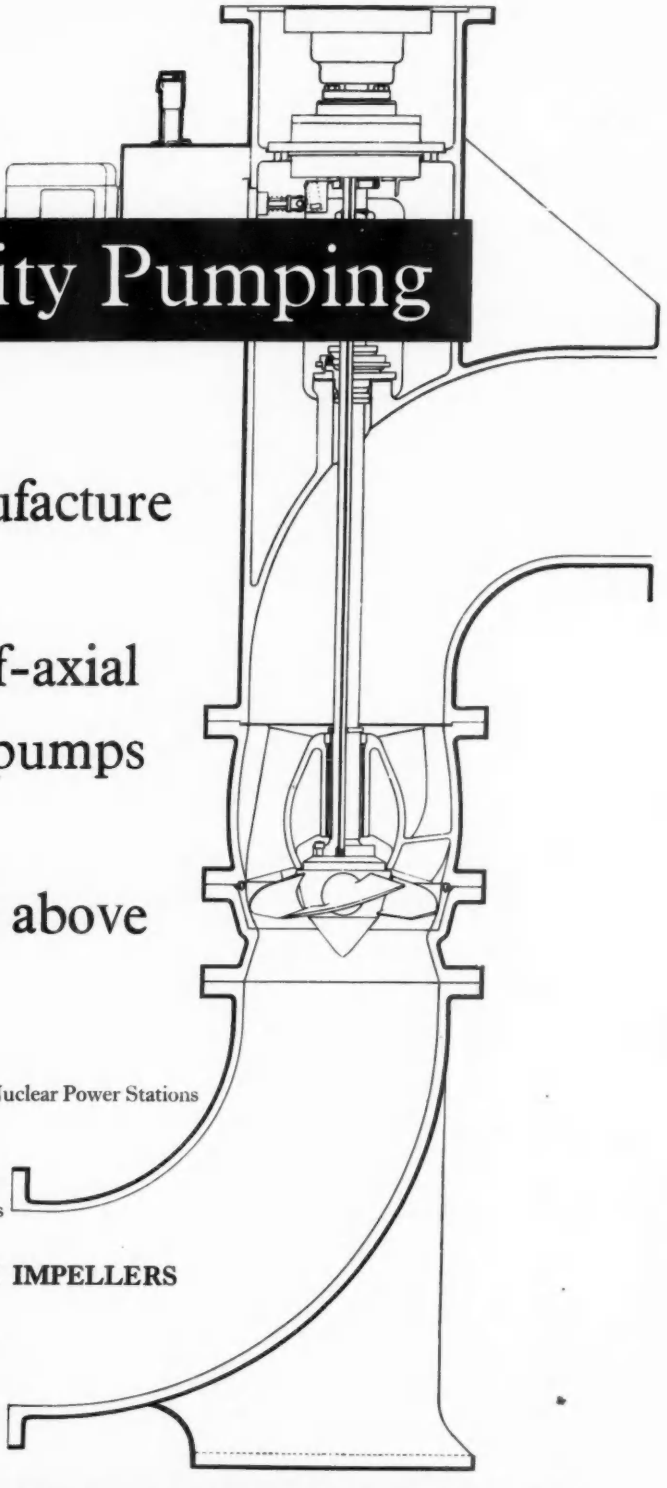

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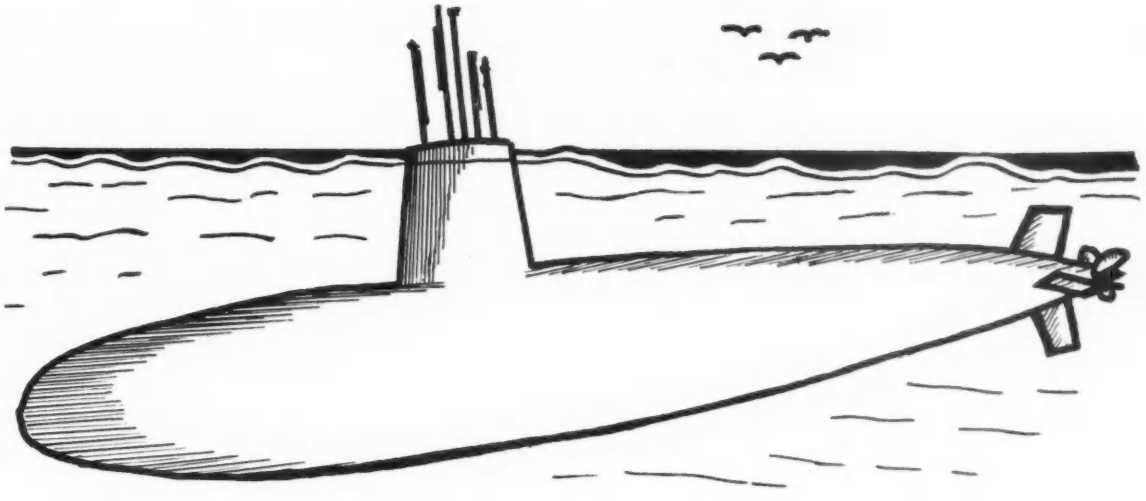

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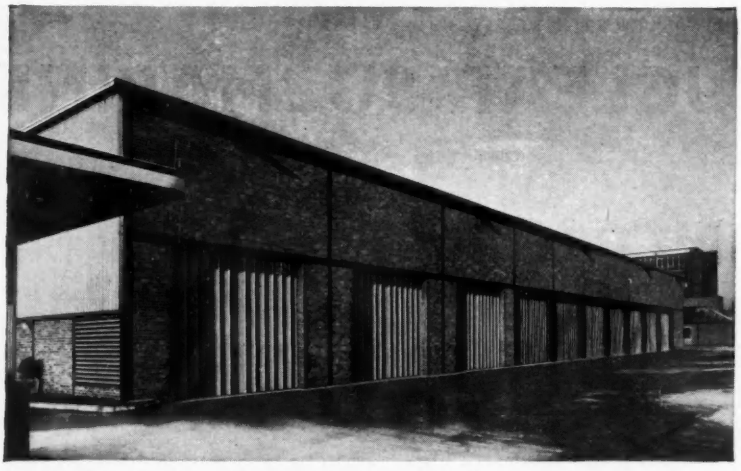

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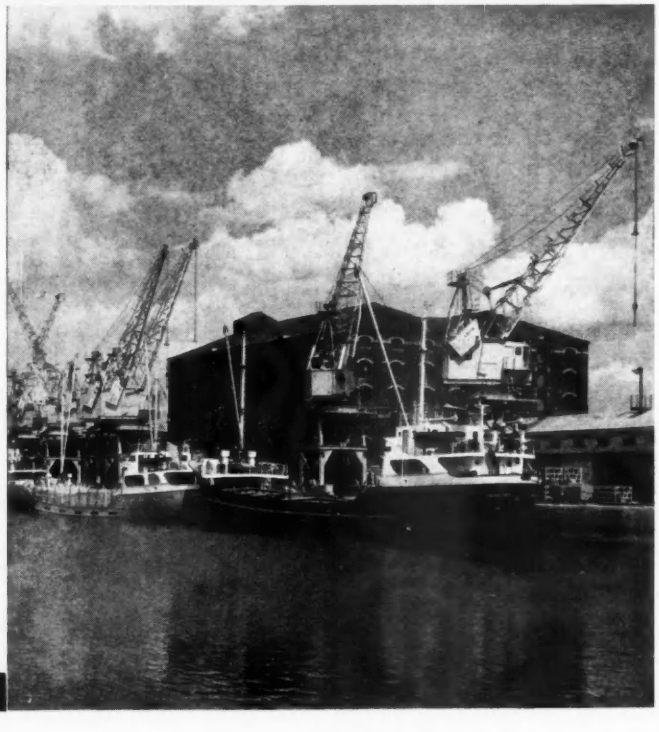

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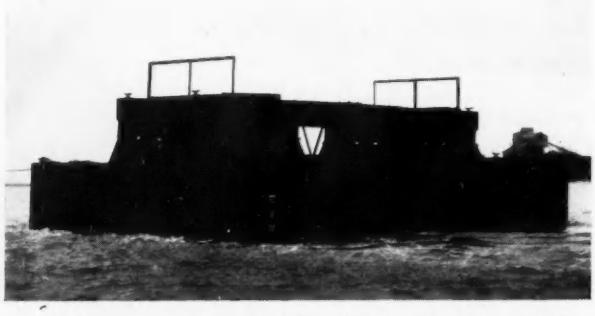

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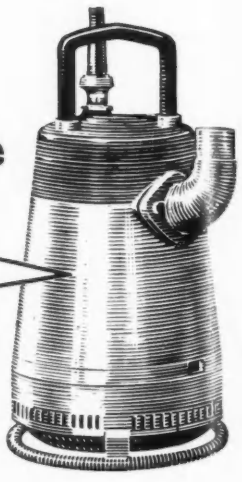

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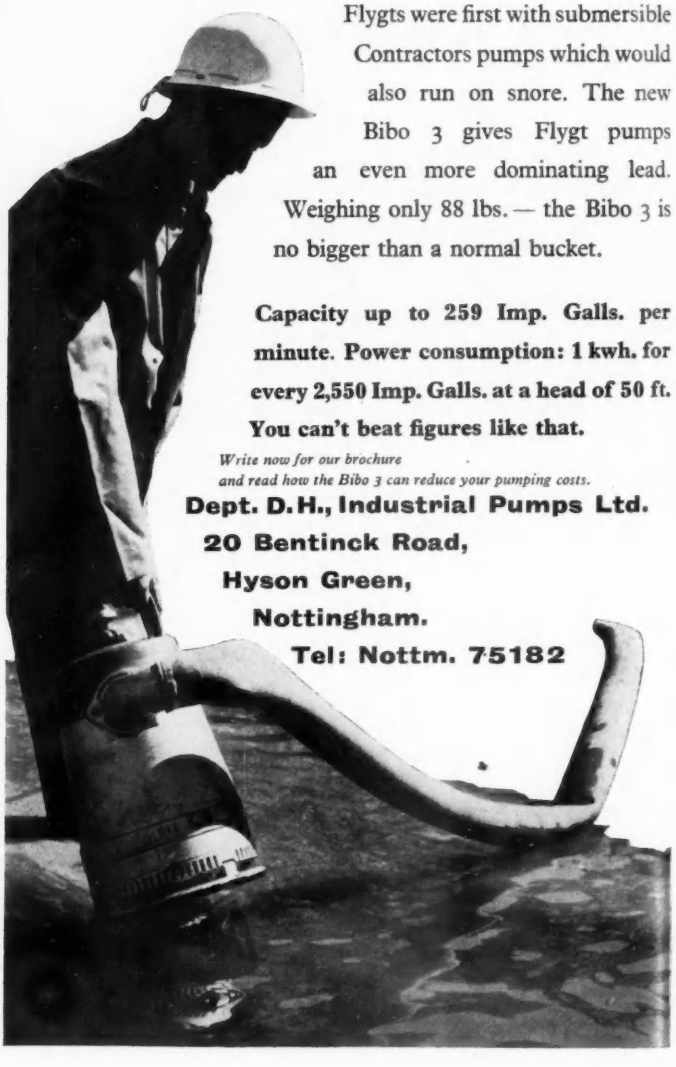

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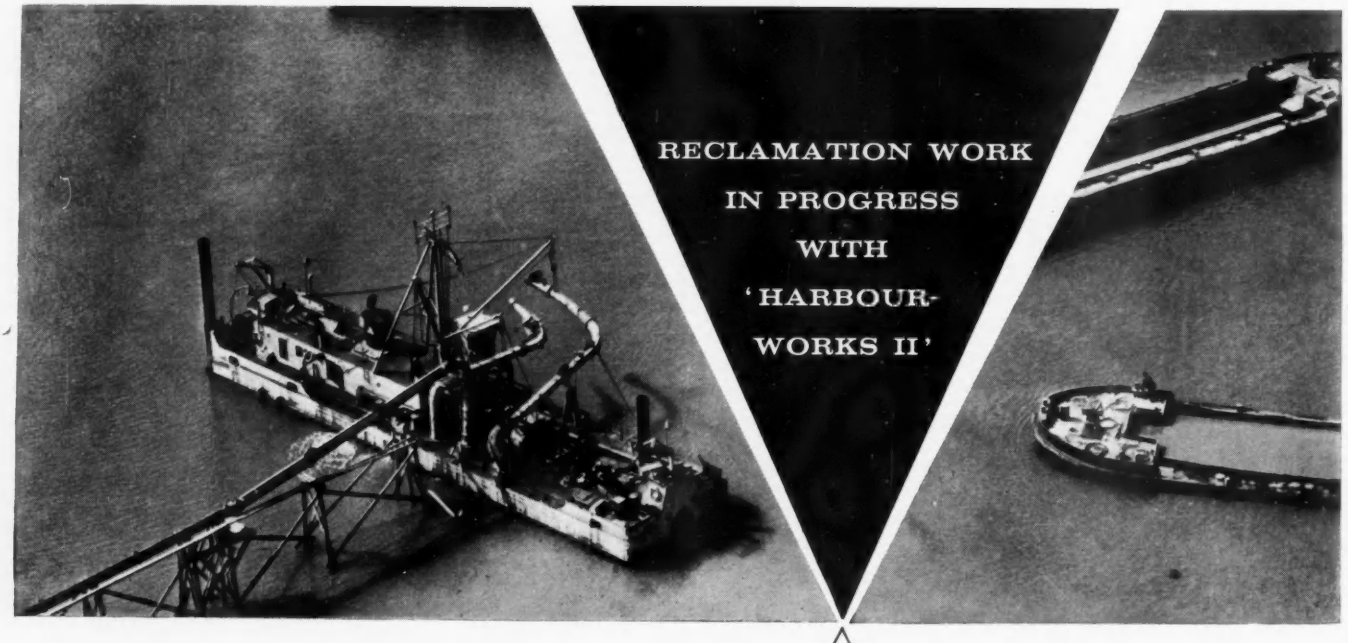

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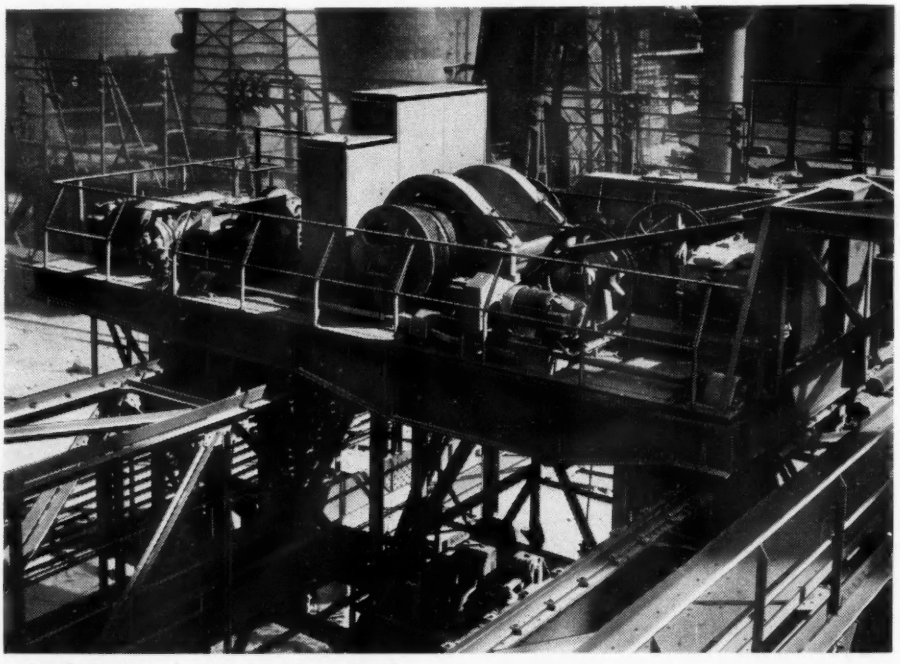

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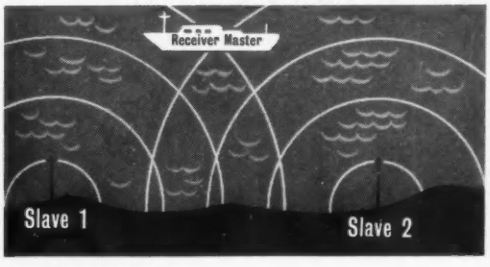

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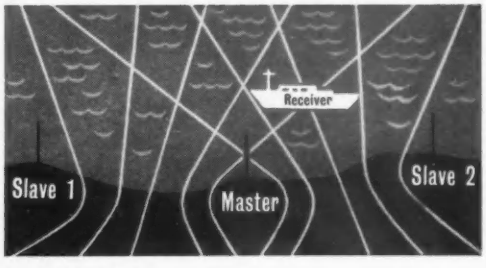

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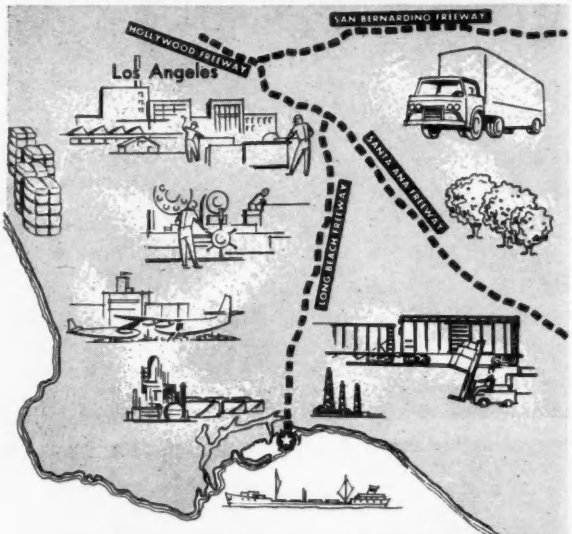

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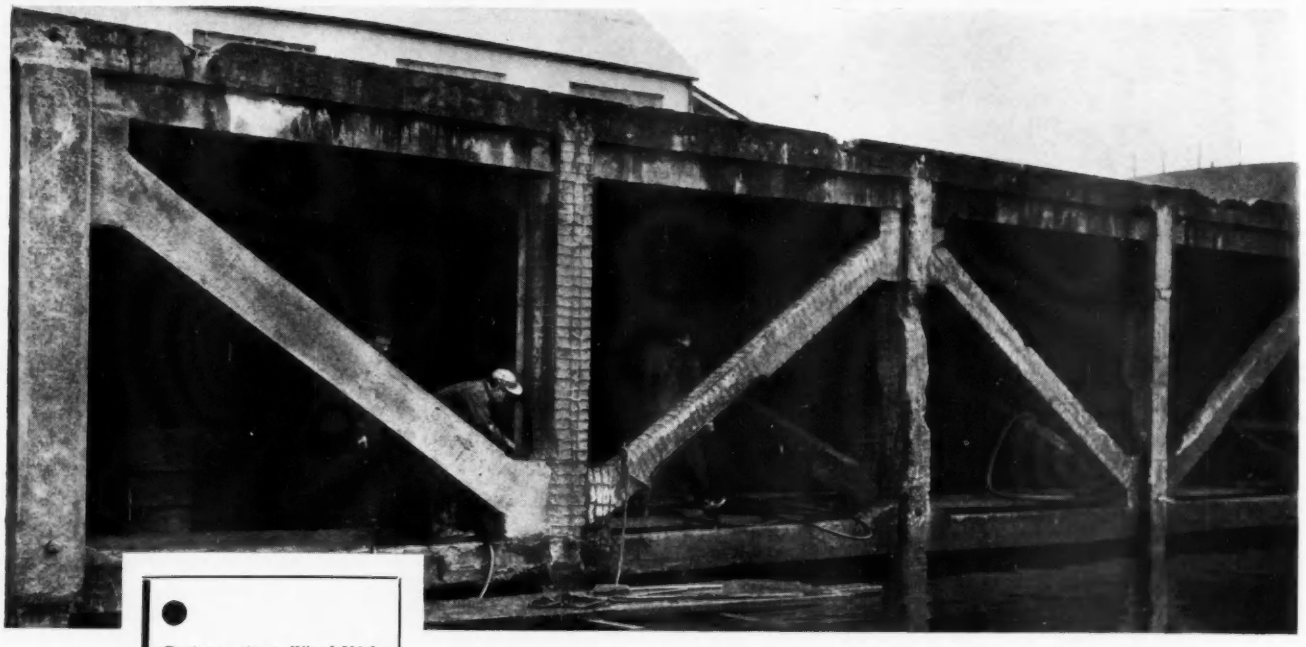

Gunite repairs to Wharf 390-ft. long x 40-ft. wide for Messrs. Esso Petroleum Co. Ltd.

On right, defective concrete cut away; Left centre, fabric reinforcement fixed; Left gunite completed.

MAIN CONTRACTORS: The Norwest Construction Co. Ltd., Liverpool.

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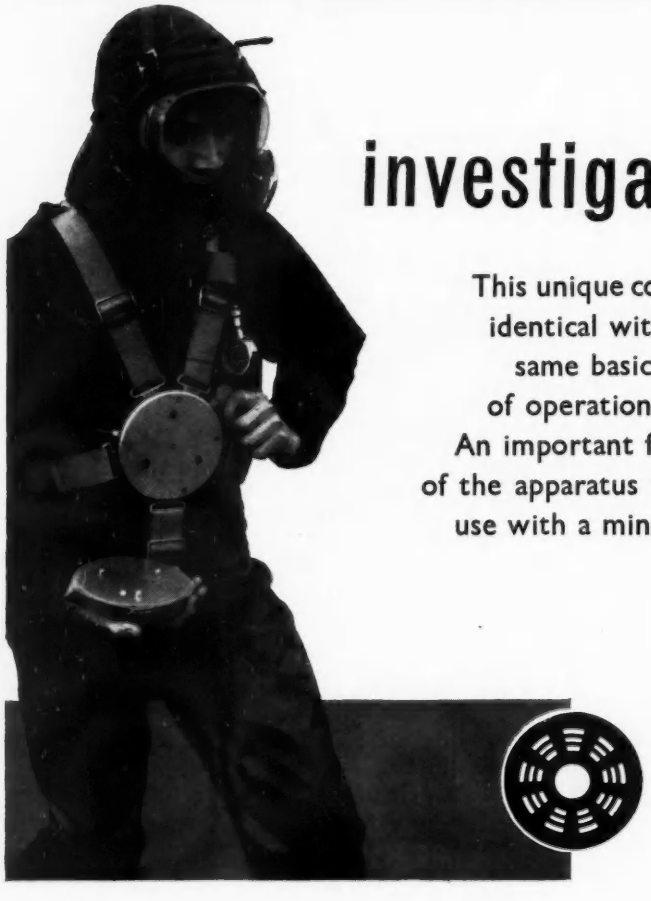

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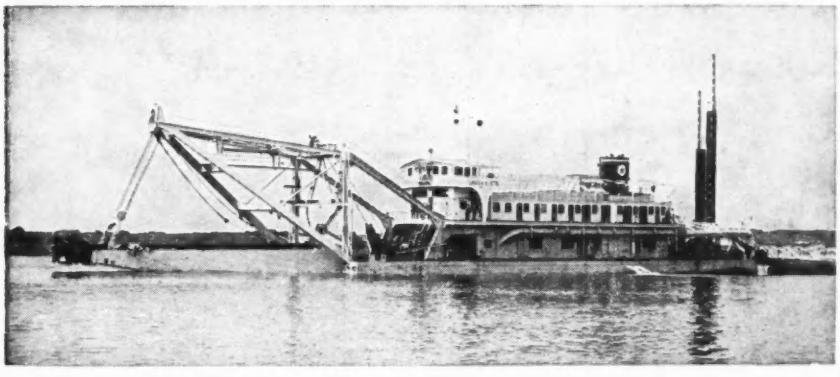
A BI-MONTHLY BULLETIN ON DEVELOPMENTS IN DREDGING

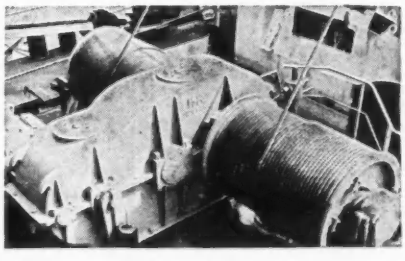
THE USE OF STEEL WIRES IN DREDGING



In the early days of dredgers much of the deck equipment in use on ships was adapted to suit the dredging field. In particular this applied to the dredger winches.

The windlass was one of the best developed forms of deck machinery in the shipping world, available in the correct horsepower to make it suitable for use on dredgers. Nothing could be more natural, therefore, than to adapt it to the needs of the dredger, but retaining the cable lifters and using chain for traversing the area to be dredged.

The wear on both chain and cable lifters as a result of continuous use led to the development of the chain barrel, and this retained its popularity for a relatively long period. The fate of the chain was settled, however, from the moment that it was appreciated that results at least equivalent to the chain could be obtained by using steel wire ropes in conjunction with winches, generally at less cost and with a saving in weight. Thus the steel wire rope made its glorious entry and today few chains are found on a non-propelled dredger. It can safely be said that the dredging industry with its many specialized requirements had provided the necessary incentive for the development of steel wire ropes of special construction, which have subsequently been of benefit to others. A comparable engineering plant requiring specialized steel ropes of greater variety would be difficult to name. Steel wire ropes are required to



possess a combination of the following characteristics dependent on their functions: Suppleness or flexibility, great strength, corrosion resistance and resistance to wear. Nowaday it is possible to select from a wide range of steel wire ropes to obtain optimum results in each application. Some of the steel wire ropes on dredgers are:

the hauling or swing wire - which does not require the corrosion resistance of some of the wires used on dredgers, its life being mainly determined by wear. It follows, therefore, that it must be highly resistant to wear and be able to sustain mechanical damage.

ladder hoist wire - here the possibilities of mechanical damage are less and wear is not so important, but corrosion resistance is all important since the same part of the rope is between wind and water for prolonged periods.

spud hoist wire on cutter dredgers. This wire presents difficult requirements in that it is subject to wear and fatigue, heavy loads must be taken up and corrosion is likely to occur.

I.H.C. Holland have considerable experience in the application of steel wire ropes on dredgers as a result of their having built a large number of these vessels.

Readers of "Ports and Dredging" will possibly remember having read about this subject. That is one of the advantages of regularly receiving this free I.H.C. Holland periodical.

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A French shipowner has entrusted I.H.C. Holland with the construction of two 1400 ton coasters for Mediterranean traffic. The first one is to be delivered towards the end of this year.

*

The trailing suction hopper dredger "W.D. Mersey" has been delivered to its British owner. A Dutch contractor has ordered an identical vessel.

*

The bucket dredger "Foremost Southampton" destined to a British contractor, is now doing its trials. It is a diesel-electric job of 164 ft. x 34 ft. 5 in. x 13 ft. (50 x 10.5 x 3.95 m.) and a bucket capacity of 850 litres.

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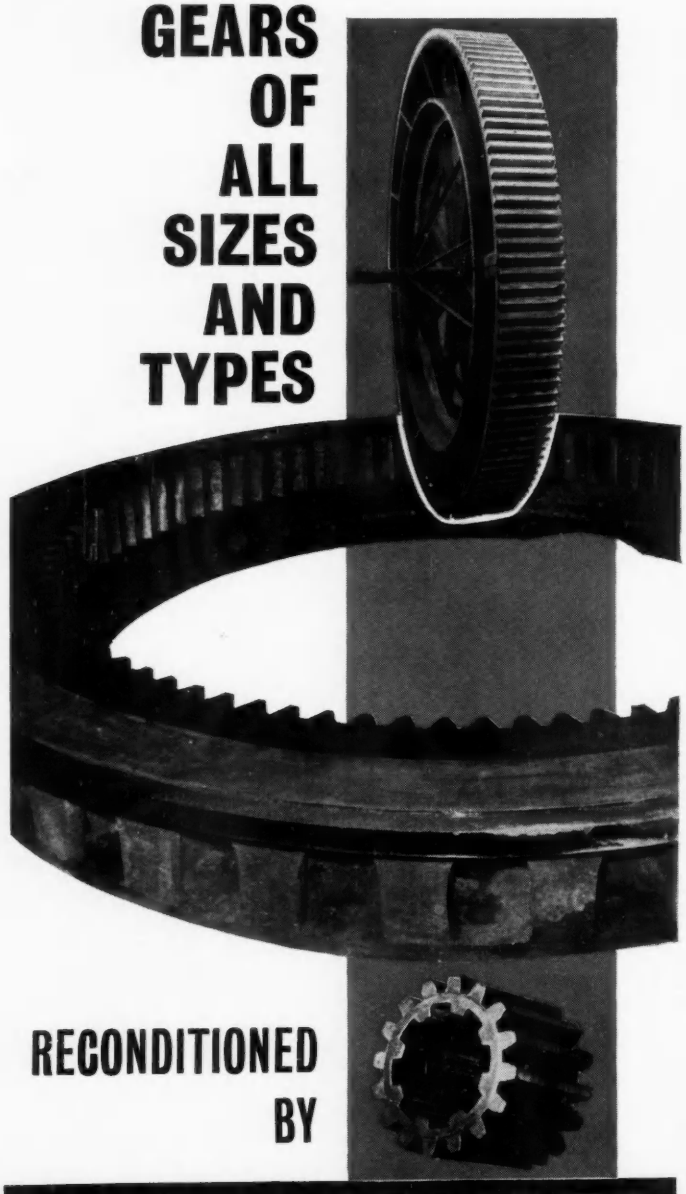

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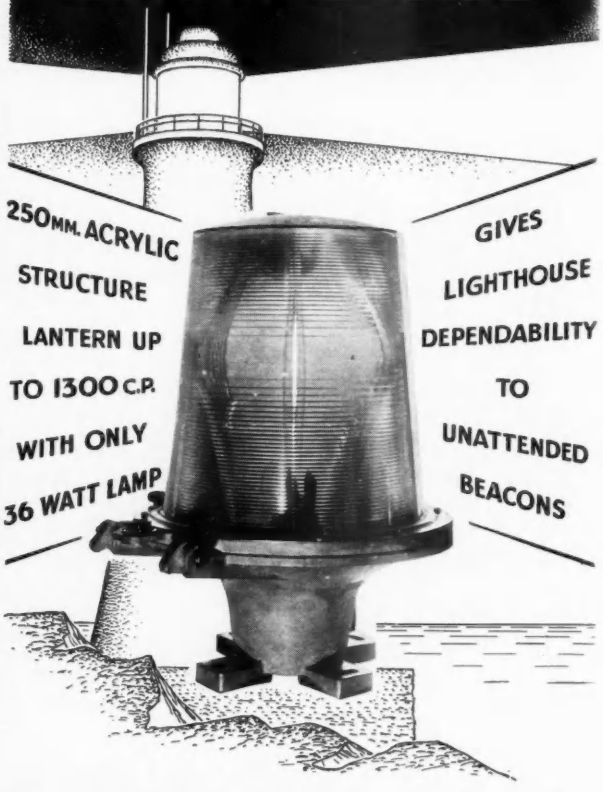
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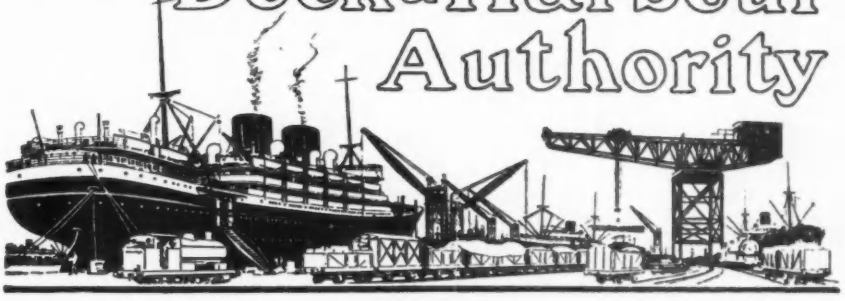

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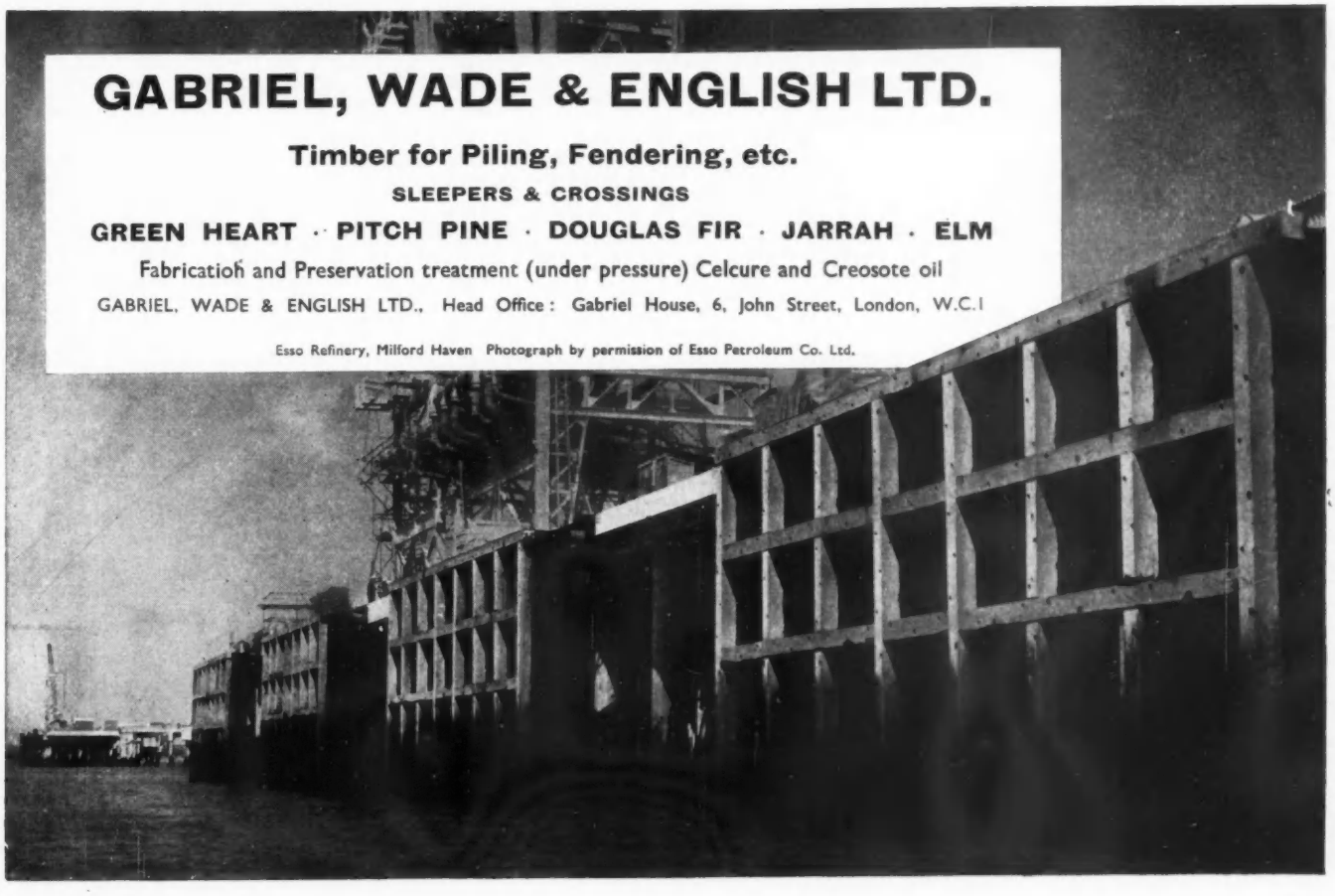
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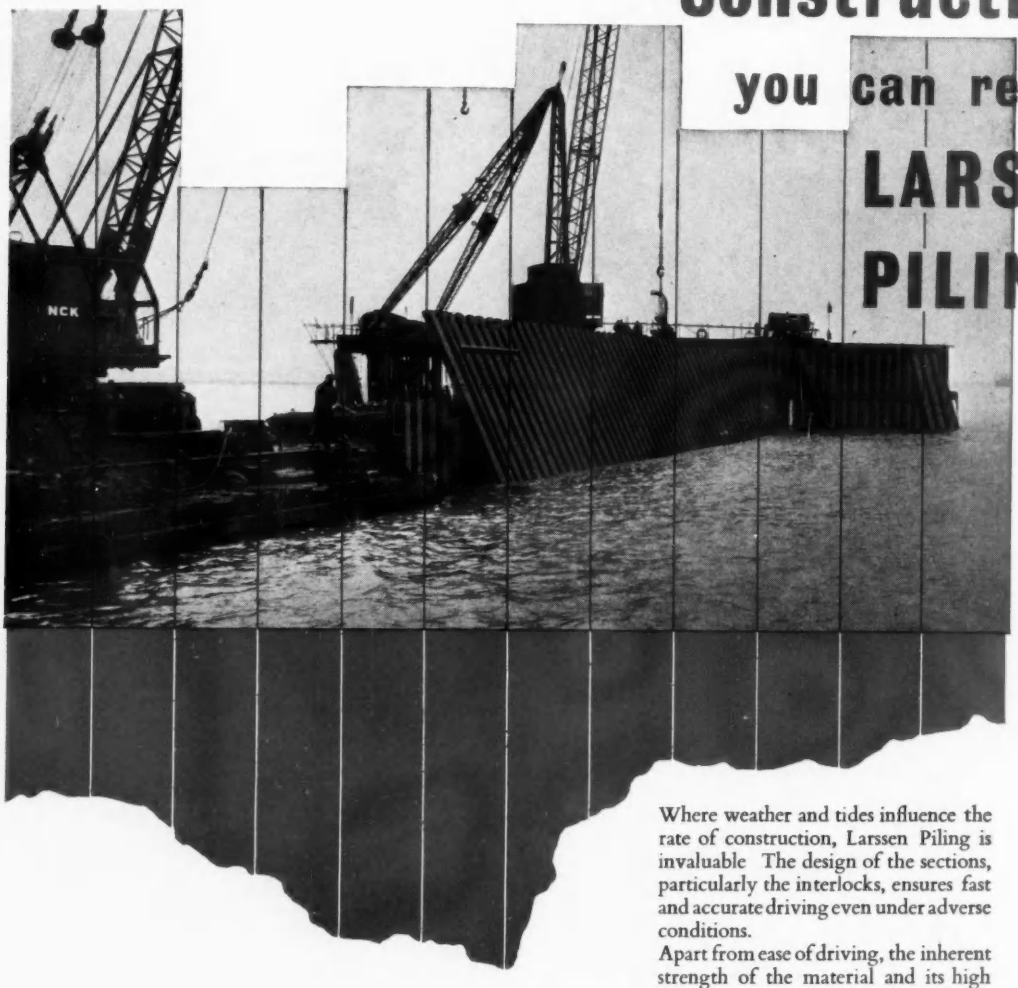

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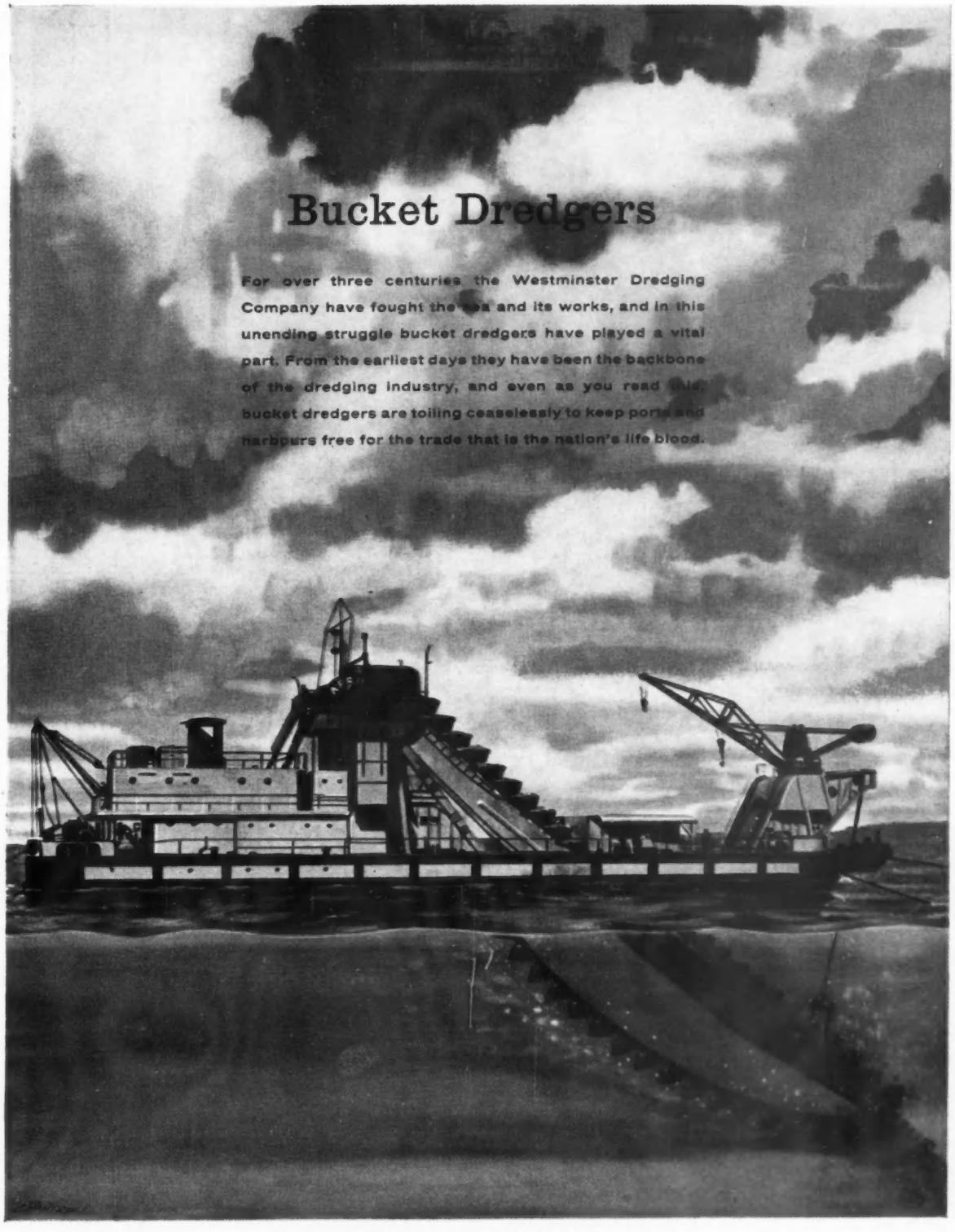
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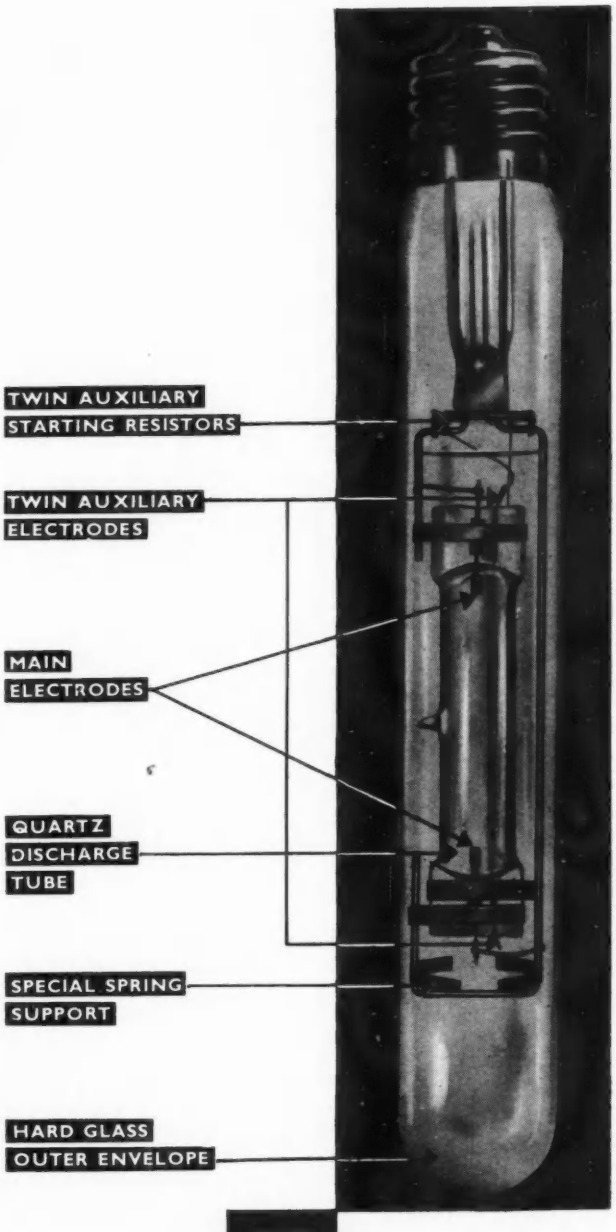

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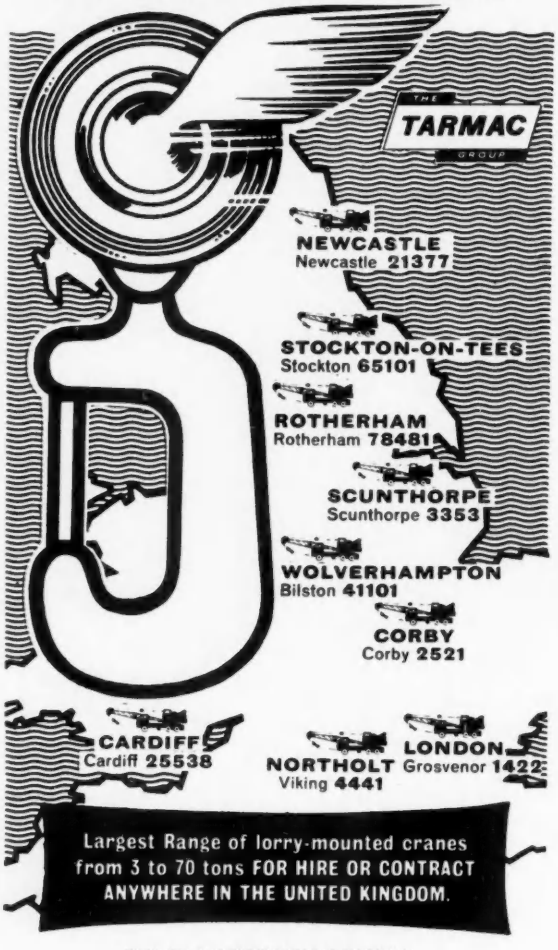

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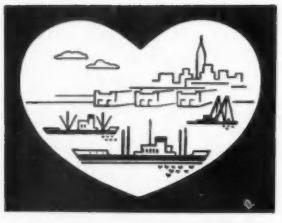

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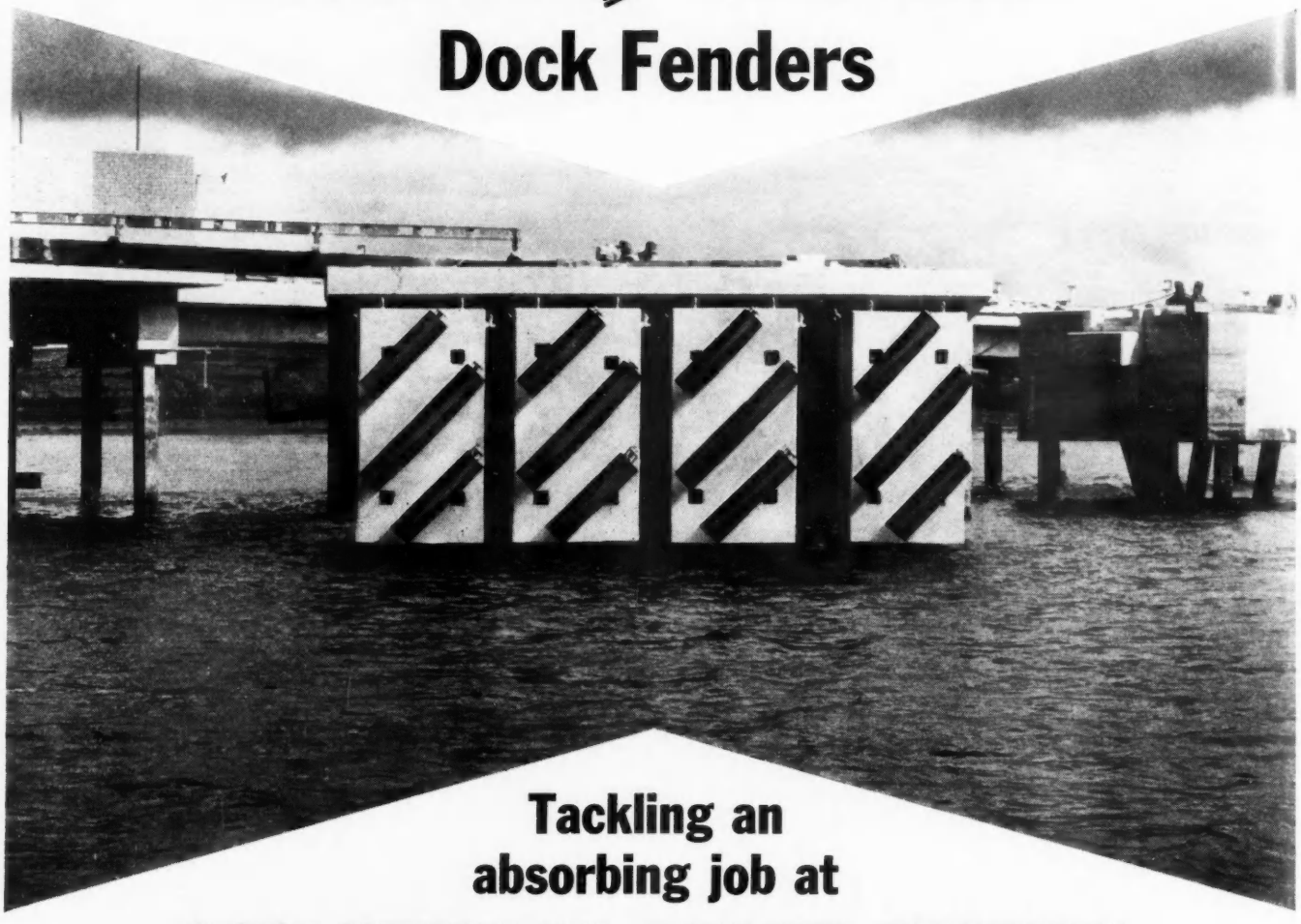

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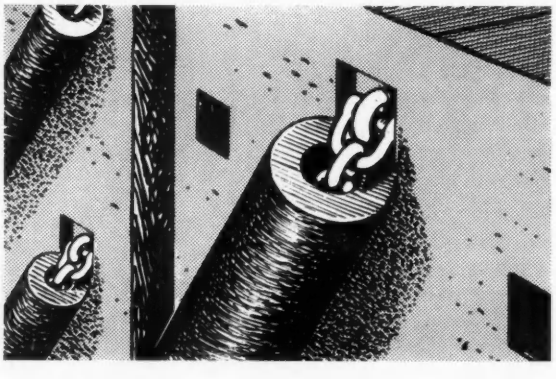

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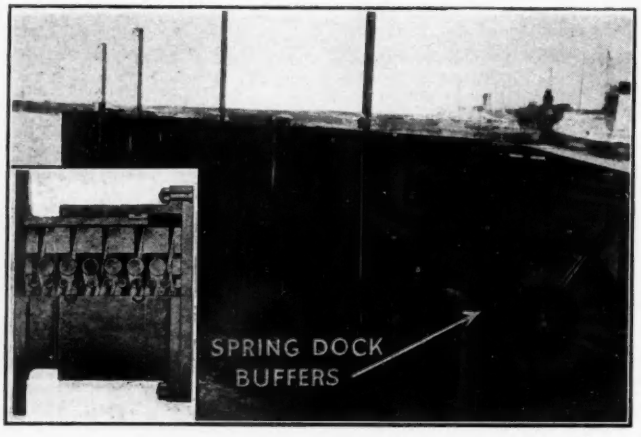

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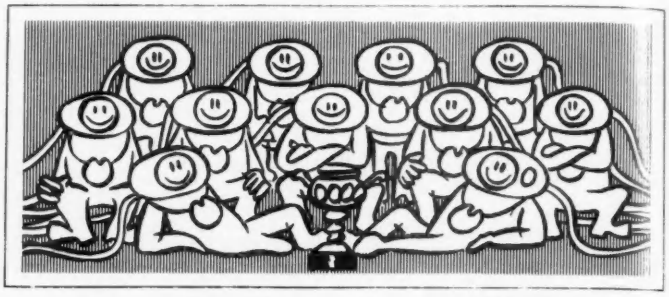

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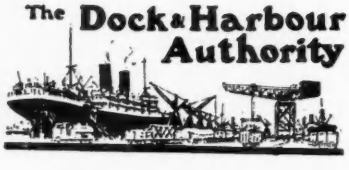

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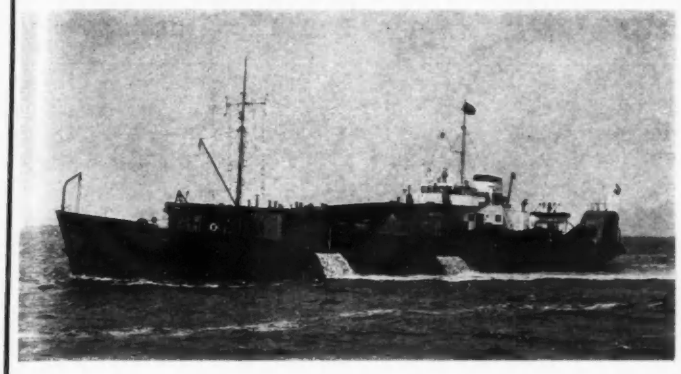

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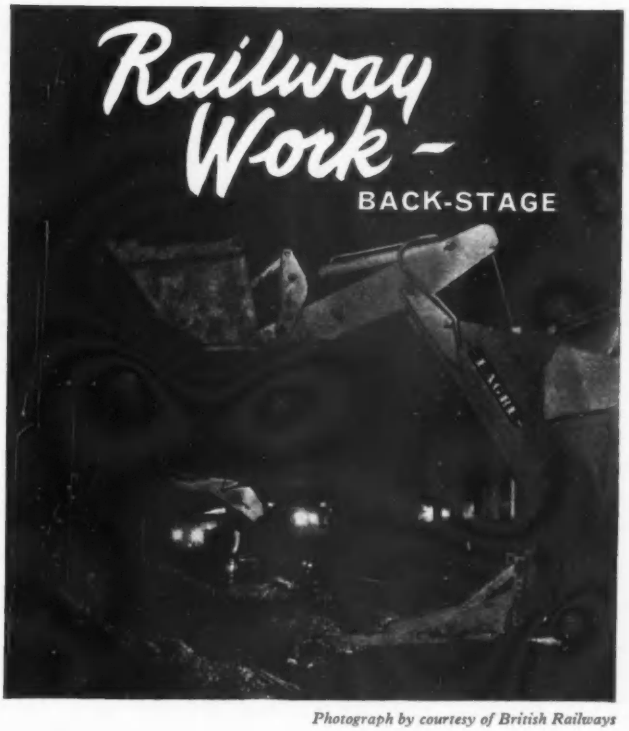

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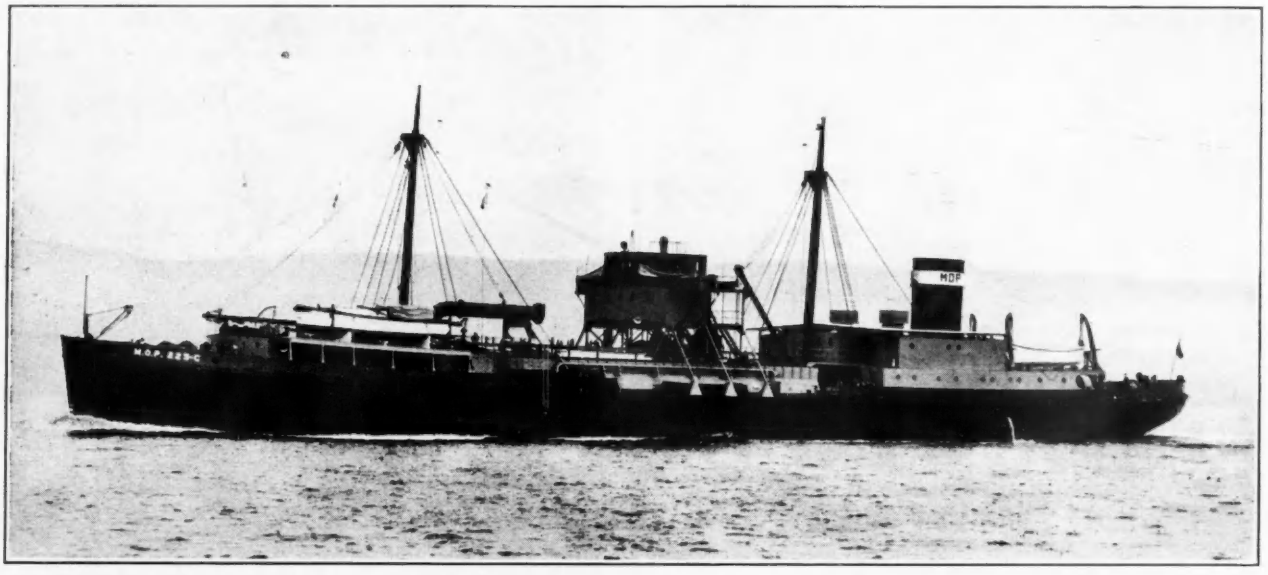

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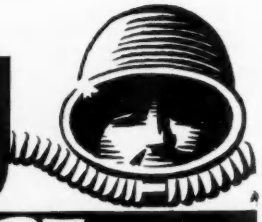

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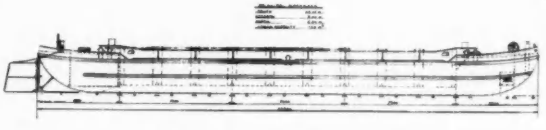

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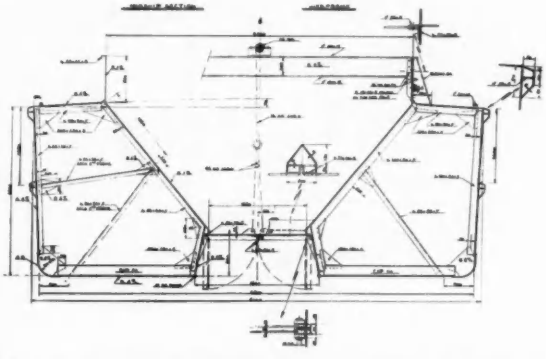

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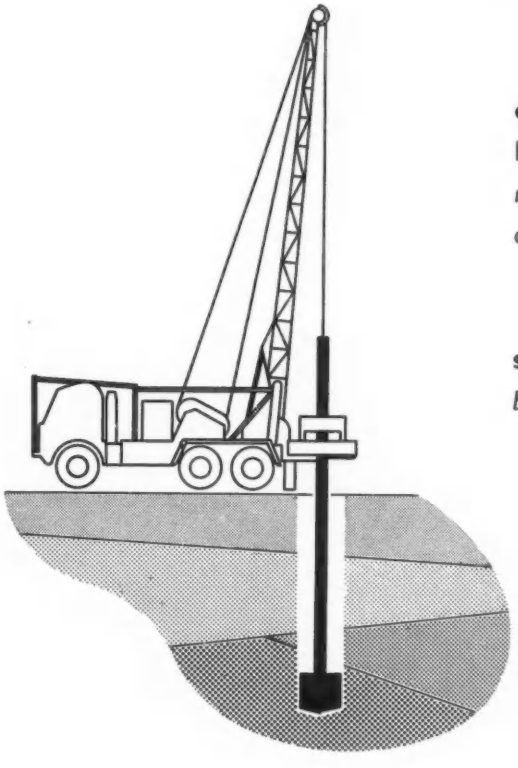

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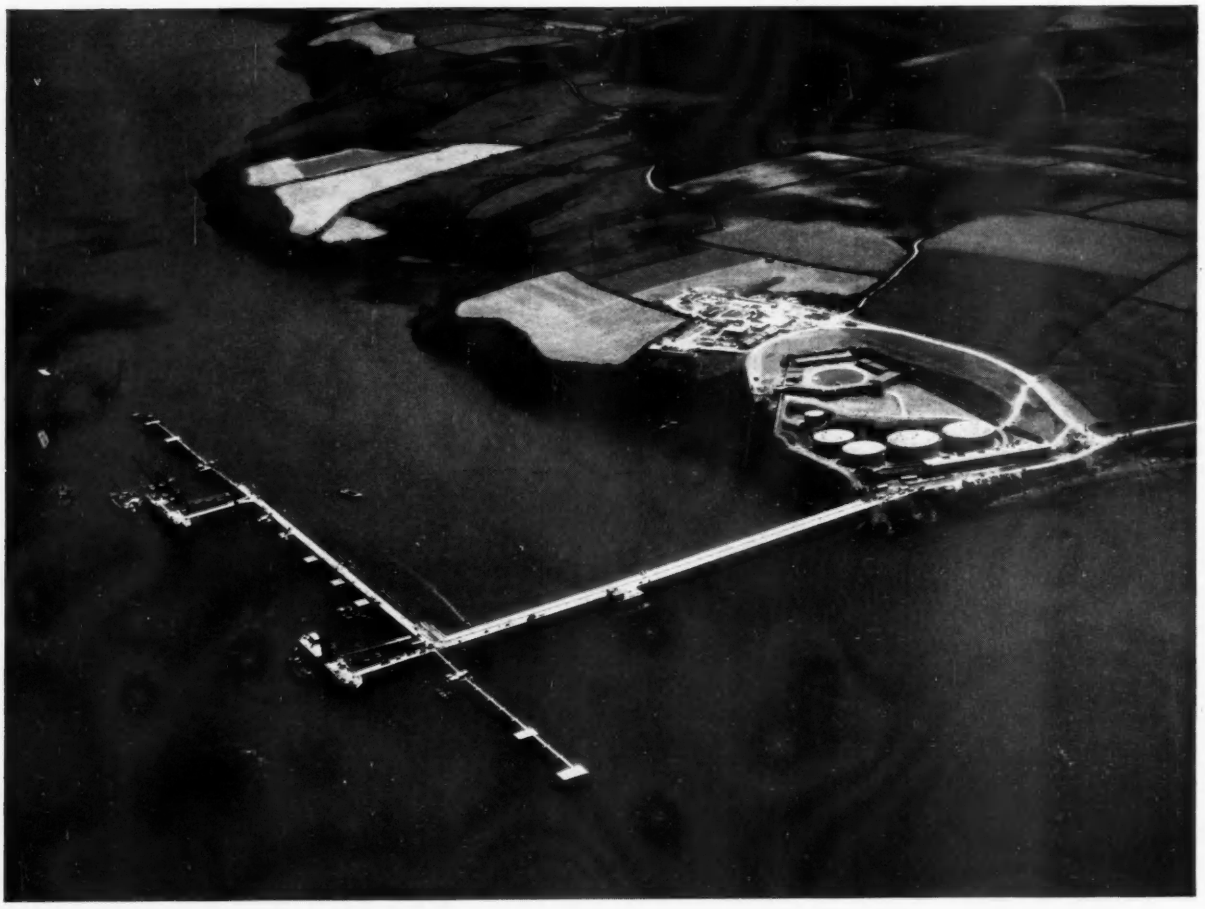

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